Relativity and View Effects

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Summary

This paper describes a new interpretation of relativity.

The concept of rest frames clarifies the initial assumptions used in General Relativity and underlines the necessity of a review of whatever impacts relativity. View effects are examined in addition to interactions. The Ehrenfest paradox is solved. View effects specific to each point of view are the solution. A curved space cannot be compatible with relativity. Both the line of sight and the path of the object are contracted. The calculations are based on path speeds at path points independently of speed orientation and direction. Differences in clock time rates remain as previously calculated. Special Relativity is mainly reduced to the examination of Lorentz boosts. The concept of a seen speed is introduced. Examples of view effects are discussed. The paths of stars seen from the earth are not compatible with the interpretation of Special Relativity.

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

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 that are compatible with view effects. Several differences subsist.

Relativistic energy is examined. The relationship of Special Relativity between speed and kinetic energy is confirmed for electromagnetism where path speeds are limited to the speed of light. In all other interactions massive objects have no speed limit and total energy is composed of rest mass energy plus a kinetic energy as defined in classical mechanics. Relativistic paths are impacted by view effects that do not convey energy. The new interpretation impacts the analysis of empirical evidence. Dark energy should be calculated without relativistic contributions to energy.

Inertial behavior is due to energy exchanges originating from interactions and impacting the kinetic energy. Inertial masses are redundant, but this does not introduce gravitation to General Relativity.

The respective impacts of relativity, gravitation and quantum mechanics are discussed. The role of relativity is limited to a deformation of the information provided to an observer. Newton's gravitation laws apply to the photon scale independently of quantum properties of the photon as described by the deflection of light by the sun.

1.On inertial reference frames

Galileo Galilei introduced the notion of inertial reference frames, to be called inertial frames, where the laws of motion could 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 while maintaining the validity of the laws of motion in inertial frames. 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 Euclidian space such as classical mechanics and 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.

In this paper 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 or of whatever else. An observer always observes out of his own rest reference frame, to be called a rest frame. A rest frame {x,y,z} is in all circumstances an inertial frame relative to a chosen reference, in this case the observer. Therefore, the laws of motion of classical mechanics and Newton's laws are valid in 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.

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 $\left\{x^{\alpha}\right\}=\left\{ct,x,y,z\right\}$ and the rest frame of the object is $\left\{\boldsymbol{X}^{\alpha}\right\}=\left\{c\boldsymbol{\tau},\boldsymbol{X},\boldsymbol{Y},\boldsymbol{Z}\right\}$

t is the time of the clock of the observer and $\boldsymbol{\tau}$ is the time of the clock of the object, c is the speed of light.

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

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

where p is an affine parameter, for example the time $\boldsymbol{\tau}$.

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

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

and results in the equation of General Relativity:

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

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

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

Equation [1] is valid for all points on the path of the object and equation [2] is specific to the same path.

Equation [2] results exclusively from the rest frame concept. Contrary to General Relativity (1) it depends neither on the equivalence principle nor on gravitation. 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 act by deformations of seen space and paths without using forces or exchanges of energy. In what follows the interactions shall be as described in classical mechanics and 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 known under the name of aberrations.

Observer 1 and observer 2 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 1 has an umbrella and stays in place. Observer 2 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 1 still sees the raindrops following straight-line paths pointing to the center of the earth.

Observer 2 gets more and more 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 2 sees the raindrops following a curved path. Observer 1 still sees a straight-line path.

Observer 3 is the raindrop travelling next to the observed raindrop. They have a relative speed of zero. Observer 3 sees the other raindrop not moving at all.

The movements of an observer relative to an object 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 to predict the values recorded by an observer. A camera always takes pictures out of its 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 contraction by a reciprocal Lorentz factor

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

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 inertial frames. In what follows the paradox will be considered a thought experiment with a totally rigid disc. 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 radius r_d of the disc is shared with the circumference of a circle of 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 thereby not respecting 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:

1) It should be compatible with view effects.
2) 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.
3) The path speed of the object impacts the relativistic view effects. A higher speed results in a higher contraction.
4) 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. It could not be a contraction factor in this case as that would not respect condition 4).

The overall contraction factor applicable to both the radius and the circumference of the disc, respecting thereby condition 4), 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 angular velocity of the disc.

v_c is the uncontracted path speed of a point on the circle with radius r_c .

v_d is the uncontracted path speed of a point on the circumference of the disc.

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

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

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:

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

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

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

The impact of the overall contraction factor 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 contracts.

What could be retained from Special Relativity? A reciprocal Lorentz factor as equation [3] is used for the determination of contribution factors and for the calculation of the contracted length of a straight-line path in a Lorentz boost. In what follows the contribution of Special Relativity will be mainly based on the examination of Lorentz boosts.

The straight-line going from the observer to the object shall be called a ''line of sight''. A line of sight can represent an accelerated path as is the case for the radius of the Ehrenfest paradox.

A path subject to view effects can be of any origin such as interactions or movements of the observer. The contraction of an infinitesimal path segment keeps the path orientation and direction unchanged. Both the infinitesimal uncontracted and contracted path segments are seen within the same angle of view. The smaller contracted segment is 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 both related triangle lengths at that angle. For infinitesimal path segments both lengths almost merge with the line of sight to which that factor applies as well independently 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 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. That speed applies to the calculation of the corresponding contribution factor as done for the Ehrenfest Paradox disc and the overall contraction factor of each line of sight can be calculated using 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.

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 applies the contraction factors to paths and lines of sight using speed independently of its 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 a relativistic view effect.

We record the paths of the past including the impact of relativistic view effects that could be considered as aberrations of light in accelerated rest frames.

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 being the time of the clock of the object and t being the time of the clock of the observer.
x is the space coordinate of the rest frame of the observer applying to the path of the object.
ds^2 is 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.

$\gamma = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}$ is the Lorentz factor.

Equation [5] introduces a difference in clock rates due to a constant speed between two clocks with times t and τ . This effect is called velocity time dilation. When switching the roles of the observer and the object an observer's clock time will always be dilated respective to the clock time of the object as the calculations are done in the rest frame of the observer and therefore any impact on the clock of the observer will be assigned to a corresponding impact on the clock of the object.

Clock rates also depend on gravitational time dilation. A light wave travelling against a gravitational field is subjected to a redshift due to a Doppler effect as a gravitational field impacts the relative speed. Furthermore, a relative speed of two clocks contributes to the redshift by an additional Doppler shift factor. The total redshift difference impacts the relative clock rate as calculated from the Doppler effects.

The clock nearest to the origin of the gravitational field will always have the slowest rate. This differentiation is possible because the redshift introduces an information on the orientation and direction of the electric field.

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. A corresponding difference in clock times depends on the time spent with each value of a difference in 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 must be accounted for as otherwise the system could not perform.

The expression used for the contribution factor of space contractions can be derived from velocity time dilation. We have from [5]:

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

The values of both the uncontracted and the contracted infinitesimal segment lengths dL and dL_c can be calculated from the path speed v in the rest frame of the observer by using the time intervals dt and $d\tau$ necessary to travel from an endpoint of the segment to the other one:

$dt \cdot v = dL$ and $d\tau \cdot v = dL_c$ therefore: $dL_c = \frac{1}{\gamma}dL$

Contributions to clock rate differences and length contractions use the same contribution factor values when calculated for velocity time dilation.

A time difference results from the impacts of the clock paths on each clock. The overall contraction factor of a line of sight is calculated from path speeds specific to each point on the line of sight and does not apply to time differences as clock times are independent of lines of sight.

Gravitational time dilation is calculated from Doppler effects that are not specific to relativity. The impacts of gravitational and velocity time dilation on path information must be corrected to match the real path of the object.

5.On Lorentz boosts

Relativity acts on space as a view effect. The initial conditions specific to each point on the path of the object and from which such effects are calculated originate from the laws of interactions combined with the contributions from the relative movements between the observer and the object.

As in classical mechanics an observer sees everything out of his rest frame which is a Euclidian space. The only impact of relativity on space is the relativistic contraction of the seen path that is embedded in the rest frame of the observer.

When using the rest frame concept with a Lorentz boost the observer is always located on the straight-line path of the object advancing at constant speed. The transformation rule for the uncontracted and contracted infinitesimal segment lengths dL and dL_c are, as calculated in the rest frame of the observer:

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

with $\gamma = \dfrac{1}{\sqrt{1 - {v^2}/{c^2}}}$

v is the constant speed of an object calculated in the rest frame of the observer with $v = {dL}/{dt}$ for a Lorentz boost as described in the previous section. This formula is equivalent to $v = {dx}/{dt}$ as both relate to uncontracted values valid in the rest frame of the observer.
t, τ , c, L_c and L 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 as described in the section ''On the Ehrenfest paradox''. The information received by the observer is limited to the observation of the contracted path of the object. He 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 seen path as recorded by the observer.

The seen speed v_s , valid for a Lorentz boost, is:

$$v_s = \frac{dL_c}{dt} = \frac{1}{\gamma}\frac{dL}{dt} = \frac{1}{\gamma} v$$

with dL_c and dL as previously defined.

A seen speed v_s is always smaller than a positive real speed v .

In Special Relativity the three space components v_f^α of the four-velocity are defined as the division of the infinitesimal not contracted segments dx^α , not seen by the observer, by the infinitesimal clock time $d\tau$, not received by the observer either. For a Lorentz boost the following formulas apply:

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

What should be interpreted as the real speed is the speed v as previously specified with, for a Lorentz boost:

$$v = v_f \sqrt{1 - \frac{v^2}{c^2}} = \sqrt{\frac{1}{\frac{1}{v_f^2} + \frac{1}{c^2}}} \qquad [6]$$

and $$v_f = \sqrt{\frac{1}{\frac{1}{v^2} - \frac{1}{c^2}}} \qquad [7]$$

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	∞

Values calculated for a Lorentz boost concern non-accelerated straight-line paths, with an observer located on the path and receiving the information on the positions of the object by light waves, limiting therefore the scope of equations [6] and [7].

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 ''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

A sphere will always be a sphere when subjected to view effects that will decrease the seen size but keep the shape. This result has already been described by the Terrell-Penrose effect (3).

Particle accelerators such as the CERN and Fermilab are examples of Lorentz boosts. The observers are the particle detectors placed on the path of the particles where particles rotating clockwise will collide with particles rotating anticlockwise when the requested speed will be reached. The particles are the objects, and their paths can be locally approximated by straight-lines.

When an object advances at constant speed on a straight-line and the observer is not located on the path of the object, the relativistic contraction results in a parallel shift towards the observer. As per

equation [4] the constant path speed applies the same overall contraction factor to all lines of sight and produces the shift.

Relativistic view effects depend on the speed 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 effect 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.

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 path speeds above the speed of light should have a value of zero and would result in a smaller overall contribution 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. This does not apply to the path of stars seen from earth where the path speed is perpendicular to the line of sight. Angular movements remain unchanged. Furthermore, the telescopes for professional use are mounted since decades in a configuration with computerized tracking to compensate for rotations of any origin previously corrected by an equatorial mount.

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 first calculations of the deflection angle date back to the 18th century and were based on Newton's laws with gravitational forces bending the path of the light particle called photon. Travelling on a straight-line path, the photon is attracted to the sun, but its high speed provides an escape after an exceedingly small deflection. A simple calculation approach is detailed in mathpages (4).

Expressed in a reference frame with the sun located in the center 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: $\tan(\theta) \cong \theta$

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 of the photon becomes:

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

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

As seen by the virtual observer located in the center of the sun the relativistic contribution to the deflection of light by the sun must match the non-relativistic path calculated with Newton's gravitation law and in particular the speed valid at each path point.

Given its sufficient accuracy, the same straight-line approach described above can be used to determine the relativistic contribution. A straight-line with path point speeds equal to those calculated for gravitation and seen by the same observer will be bent by a view effect to the same deflection angle and the same acceleration required to reach the same path speeds as with gravitation. The total seen deflection angle will therefore be double the angle calculated from Newton's laws up to factors of about order 10^{-5} due to the approximations used in the calculations. This result is compatible with the empirical evidence described in (5).

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 any accelerated object advancing on a straight line is observed as advancing on a bent line due to a view effect.

Starting from the path due to an interaction as seen in the rest frame of the observer, the deflection angle can also be obtained by selecting a sufficient number of path points, calculating the contraction of each line of sight using equation [4] with the path speed valid at the considered point and interpolating between the contracted points. This method applies to any path with speeds of no more than the speed of light.

The additional deflection due to a view effect is a consequence of the fact that relativistic effects come on top of the initial conditions resulting from gravitation and that it 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 almost 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:

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

a is the semi-major axis that can be approximated up to a factor of 10^{-4} by $a = -\frac{\mu}{c^2}$

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

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

e is the eccentricity with, as calculated in (6):

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

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

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

$r_p = a\left(1 - e\right) = 6.95638 * 10^8$ 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 relativistic contribution 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 inertial frames with constant relative speed. This does not apply to the rest frame of the photon which is accelerated due to gravitation as seen in the rest frame of the virtual observer.

Einstein wrote in his 1920 book on relativity (7):
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 since a non-accelerated straight-line path is parallel shifted by a relativistic view effect without any bending of the path.

Variations in the speed of light are compatible with relativistic view effects as these can be calculated for any photon speed.

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 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 an inertial frame when the attraction to the sun becomes negligible.

8.On General Relativity

General relativity has the best matching of empirical evidence with values calculated for 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 (9) for flat Euclidian spaces.

In General Relativity the approximations made in the calculations for weak and slowly variable fields (1) systematically use a Newtonian gravitational potential to implicitly introduce a possible space curvature. Why should Newton's laws curve the space? They can be considered to introduce gravitation in a flat space.

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 18th century. The description of gravitational waves also makes extensive use of Newtonian notions. All this is interpreted here as Einstein's choice of Newton's laws for gravitation with an added theoretical layer to account for relativistic 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 on any surface will see and measure 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 accounts for view effects of all sorts and can be compatible with relativistic view effects. There is no particular reason why the validity of that geometry should be restricted to curved spaces. It also applies to the description of curved paths in flat spaces. The rest frame concept introduces intrinsic views as well.

General Relativity gives the correct deflection angle of the deflection of light by the sun and that implies that the corresponding path and line of sight contractions should be compatible with the new interpretation. Does General Relativity introduce relativistic view effects in the pseudo-Riemannian geometry by projecting point specific reciprocal Lorentz factors of Special Relativity on the path calculated with Newton's laws for an Euclidian space? Does the geometry then produce the intrinsic view effects as described for lines of sight using contribution factors?

Einstein's equivalence principle states that it is always possible to choose an inertial frame where the laws of nature are as given in Special Relativity possibly except for gravitation. The systematic use of Newton's gravitation laws implies that they apply as well.

The new interpretation retains that the laws of nature apply to the Euclidian space of the rest frame of the observer instead of the Minkowski space of Special Relativity. A closer examination is required to sort out where General Relativity and the new interpretation produce the same results and where they do not.

The four-velocity u^μ of Special Relativity is defined as

$$u^\mu = \frac{dx^\mu}{d\tau}$$

with τ as previously defined.

The expression for $d\tau$ is somewhat different in General Relativity but reduces to the expression of Special Relativity in flat spacetime in which it has a value of zero when the path speed v reaches the speed of light as per equation [5]. Therefore, the three space coordinates v_f of the four-velocity become infinite.

How can a path speed v be the speed of light with an infinite velocity? Is General Relativity impacted at all? Is so, what would be the consequences? Is this applicable to gravitation?

9.On Energy and Speed

The relativistic energy-momentum equation of an object is:

$$E_t^2 = m_0^2c^4 + p^2c^2 \qquad [8]$$

E_t is the total energy or 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:

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

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

The term m_0c^2 represents the energy content of the mass of the object at rest. The term p^2c^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 an observer and is therefore not impacted by relativity.

The Lorentz transformation ascertains a constant speed of light valid in all inertial frames with constant relative speed and has a strong impact on the relativistic view effects.

Many experiments were carried out 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 applies to the calculation of the relativistic contraction of the radius of the Ehrenfest disc.

One of the most accurate if not the most accurate measurement was carried out by Meyer et al (8). The expression

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

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: $p = m_0\gamma v$

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 carried out. The results of their measures include relativistic effects related to electromagnetism if 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. As described in the section ''On the Ehrenfest paradox'' the use of a Lorentz factor implies that a curved space does not exist.

Special Relativity defines energy using the following formula:

$$E_t = \frac{m_0 c^2}{\sqrt{\left(1 - \frac{v^2}{c^2}\right)}} = \gamma m_0 c^2 \qquad [9]$$

Equations [8] and [9] are equivalent and each can be calculated from the other equation.

Equation [9] 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.

As described for the Ehrenfest paradox, a rotation of the disc produces a relativistic view effect 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? A rotation of an observer cannot be that, and the interpretation of Special Relativity must be reviewed.

Relativistic view effects are specific to the transmission of information on the path of an object. The speed of information transfer is, in most cases, the speed of light applying to the line of sight of the observer. The calculation of such view effects uses Lorentz factors. A Lorentz factor introduces the dependency on the speed of light and thereby on its value in inertial frames. The supposition that the path speed v of the object should be limited to the speed of light results from an interpretation of equation [9]. It is advisable to examine instead the equivalent equation [8] that gives more detailed information to understand relativity and energy.

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 the kinetic 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 speed of light and require further examination.

Photons travel at the speed of light. As confirmed by experiments (10), 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. Furthermore, the relationship of Special Relativity between speed and kinetic energy was measured and confirmed (11) as well. Therefore,

the energy equations [8] and [9], which depend on the Lorentz factor, apply to electromagnetic interactions.

The Lorentz factors are also used in the calculation of relativistic view effects which do not impact energy as they result in a distortion of reality as done for instance by a curved mirror.

An information on the path of photons is delivered by the photons themselves and that transmission introduces the relativistic view effects. The deflection of light by the sun provides the empirical evidence matching this interpretation. View effects have no impact on energy.

Other interactions of classical mechanics such as gravitation relate neither to the Lorentz factor nor to a limitation in speed and no corresponding impact on energy applies to these interactions. Why should there be a speed limit in these cases?

The Maclaurin series is valid for equation [9] as well. 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 energy calculated in electromagnetism where they account for the impact of particles limited to the speed of light. Such terms do not apply to other interactions where they would describe non-existing energy resulting from a wrong choice of energy formula. 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 remains fully valid in classical mechanics including gravitation but excluding electromagnetism.

A path speed v specific to electromagnetism is limited to the speed of light. A speed v is not limited to the speed of light whenever it does not relate to electromagnetism.

Energy defined in Special Relativity was interpreted using the implicit assumption that it was valid for any interaction. Such energy should only apply to electromagnetism.

A possible test consists in measuring the energy required to accelerate the points on the circumference of a rotating disc up to the speed of light. Will the energy formulas [8] and [9] be confirmed? The observed contractions of a disc turning at various speeds may help confirm the overall contraction factors applying to speeds of less or more than the speed of light.

Equations [6] and [7] result from a confusing relationship of the speeds v and v_f. The speed v is the real speed and $v_f = \gamma v$ could be interpreted as the peculiar speed used in the relativistic momentum of energy equation [8] that should not apply to gravitation.

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 whenever its mass is negligeable, but it induces view effects specific to the observer.

10.On empirical evidence

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 induce a deformation of reality. Relativistic view effects are new to physics and their impact must be analyzed.

An upper speed limit valid for any amount of energy has two consequences:

1) The impact of relativity on paths recorded by observers is described by view effects calculated with equation [4] applying to lines of sight and using Lorentz factors.
2) An infinite energy is required for particles with a positive rest mass to reach the speed of light as expressed by equation [9] which uses a Lorentz factor.

View effects originate from a path information delivered by particles of limited speed and depending on electromagnetism. View effects do not contribute to energy. Electromagnetic forces relate to energy equation [9] of Special Relativity. They are negligeable in the universe scale as positive and negative charges cancel out over large distances where gravitation rules. Furthermore, gravitation is unrelated to Lorentz factors and no upper speed limit applies. The kinetic energy E_g valid for gravitation is then given by:

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

A first conclusion is that the calculation of dark energy shall be reviewed to discard sources which do not contribute to energy and to apply the correct formula for the kinetic energy of gravitation.

Relativistic view effects impact the images recorded by eyes or sensors. When such view effects apply, for circular and straight-line paths with a constant object speed, the real speed v is obtained by dividing the smaller observed speed v_s by the 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. The cosmic distance ladder will be impacted whenever measured or calculated distances include relativistic view effects. All this may help explain dark matter and the discrepancies in the measurements of the Hubble constant. The impact of superluminal path speeds on events subject to extreme forces and amounts of energy, such as due to black holes, remains to be determined. A speed not limited to the speed of light may help validate the inflation period.

11.On inertial behavior

Inertia is tied to inertial frames and to inertial behavior. Mach considered that reference frames were inertial respective to the distribution of masses in the universe. The rest frame concept provides a simpler explanation.

In classical mechanics interactions of any sort use exchanges of energy including non-relativistic kinetic energy. Exchanges of energy explain inertial behavior. An object can be accelerated when absorbing energy from whatever source and can be decelerated when transferring energy to other objects. An inertial reaction is proportional to the exchanged kinetic energy. There is no need to introduce yet unknown interactions. They would act in the same way. Relativistic view effects introduce a distortion of reality and do not contribute to inertial behavior.

Energy originating from any interaction can contribute to kinetic energy which depends on positive rest masses. This implies that an energy delivered by an interaction can be expressed as depending on such rest masses of objects. It is therefore possible to use this dependence to describe the interactions of classical mechanics. Additional masses specific to interactions are redundant.

The work w is the energy transferred to or from an object using a force along a path with:

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

f is the force acting along a path C.

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

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

a is the acceleration and m_i is the inertial mass from Newton's second law.
Energy and work can be expressed as depending on the positive rest mass of objects. This dependence applies as well to the right-hand side of equation [10] and the inertial mass m_i must be the rest mass m_0.

The rest frame of the observer ascertains the continuous existence of the inertial frame in which the laws of classical mechanics are valid including Newton's laws of gravitation. The laws of classical mechanics impacting the object in the rest frame of the observer are given by differential equations describing accelerated paths.

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

12.On the contributions to physics

The role of relativity is limited to a deformation of the information provided to an observer. Reality is described by classical mechanics including Newton's gravitation laws and by quantum mechanics. Information transferred by particles limited to the speed of light is modified by contractions of the lines of sight specific to path points.

A photon with a rest mass of zero can be accelerated by gravitation as described in the section ''On the deflection of light by the sun''. As confirmed by the empirical evidence (5), the deflection of the photon by the sun is independent of the photon frequency and energy. Therefore, Newton's gravitation laws apply to the photon scale independently of quantum properties of the photon. Relativistic view effects depend on the speed of light which is also independent of the photon frequency and energy.

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