Ideas over the Special Theory of Relativity

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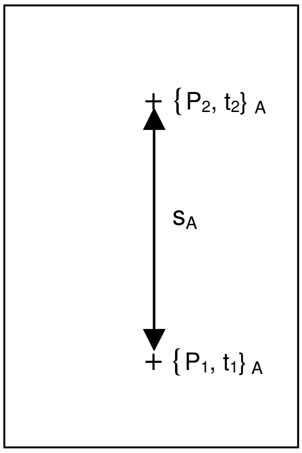
1. Basics

The postulate of relativity theory is:
„The laws of nature are equal for all moving observers regardless of the speed of their inertial frame."
Such a postulate is not valid for the physical results of observation itself. Thus the observation at different relative velocities between observer and observed object delivers different observational results, while the laws of nature itself are independent of the reference frame of the observer.
The observation of spectrum shift in the case of relative movements between the Earth (location of the observation) and distant objects in space, for example, does not mean that the removed light emitting processes are different in accordance with the observed spectrum shift.

That the results of observation depend on the reference frame will be made clear below by the example of distance measurement between two event points in space.

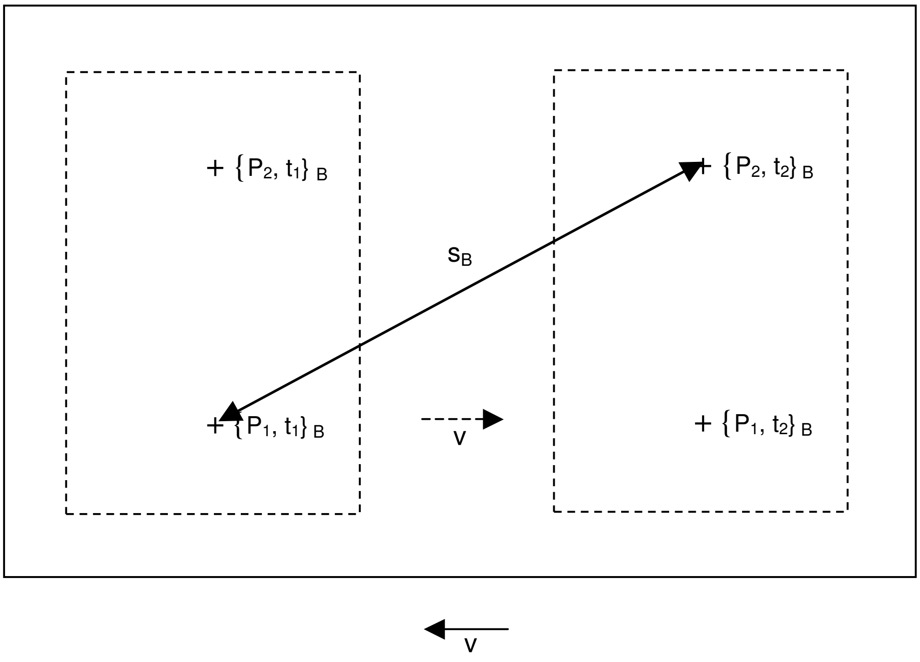


Frame A

For an observer in the above reference frame A the event points P_1 at the time t_1 and P_2 at the time t_2 are relative to the observer and hence relative to each other at rest. The distance between the two event points can immediately be stated as the distance between the two relatively static points P_1 and P_2:

$$s_A = \overline{P_1 P_2}$$

When you are at the same event as an observer in reference frame B, which is moving with the constant speed v relative to frame A, the distance between the event points $\{P_1, t_1\}$ and $\{P_2, t_2\}$ depends on the relative velocity v between the two reference frames.



Frame B

For the distance between $\{P_{1,}t_1\}_B$ and $\{P_{2,}t_2\}_B$ is:

$$s_B = \sqrt{s_A^{\,2} + [v\,(t_2 - t_1)_B]^2}$$

That means $s_B \geq s_A$

Also on the example of gravity can be demonstrated that in a reference frame, in which from the perspective of the observer the Earth is the static reference point for all celestial bodies, their movements are quite complicated, and the generality of the gravitational laws is difficult to prove. However, if you choose the sun as the static center of the reference frame, the orbits of planets will be found approximately ellipses and the laws of gravitation observed on Earth can be confirmed also in our solar system. Since our sun is not the gravitational center of the universe, also such a reference frame is not suited to explain all movements in space.

Thus, for an understanding of the laws of nature it is not indifferent, which reference frame you choose. The determination of objective reality presupposes that there is a preferred inertial rest frame, which allows uniform interpretation of the different manifestations of the same observation object, as depending on the diversity of the reference frames.

2. Views on the speed of light

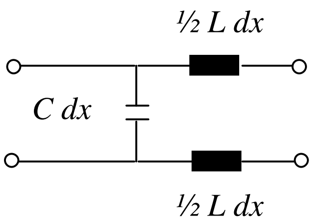
2.1 The Einstein´s postulate of the constancy of the speed of light

Starting from the Michelson-Morley experiment, the result of which questioned the presence of an ether for propagation of the light waves by delivering the same results of measurements for the speed of light against the direction of the 'ether wind' as well as in 90° angle to it, Albert Einstein developed his special theory of relativity assuming that the light in a vacuum propagates with constant speed for any observer regardless of the state of motion of the light source or the observer.

It should be noted that the Michelson-Morley experiment delivers as a result only the constancy of the vacuum speed of light relative to the light source as a reference point. The conclusion that the vacuum speed of light is constant relative to any other point of reference, regardless of the motion of the light source relative to this reference frame, can not be deduced from the Michelson-Morley experiment.

However, we know because of Maxwell´s theory and its results of electromagnetic wave propagation that the electromagnetic properties of the ‘empty’ space are given by the dielectric constant ε_o and the permeability constant μ_o. These values are adequately assured and apply at least for experimentally accessible ‘empty’ spaces.

In a first approximation you can compare the propagation of light in vacuum with the propagation of electromagnetic waves along an undamped ideal wire line.
The substitute circuit element of a length *dx* is solely determined by the parameters C and L (capacity and inductance per circuit element), as the damping relevant parameters R and G (resistive resistance and conductivity per circuit element) can be neglected for an ideal wire line according to precondition.



Circuit element of an ideal wire line

Referring to the above figure the entire wire line can be considered as a sequence of appropriate circuit elements.
As an electromagnetic wave propagates along an ideal wire line with the speed of light c_o and you can deduce from Maxwell´s equations the relationship

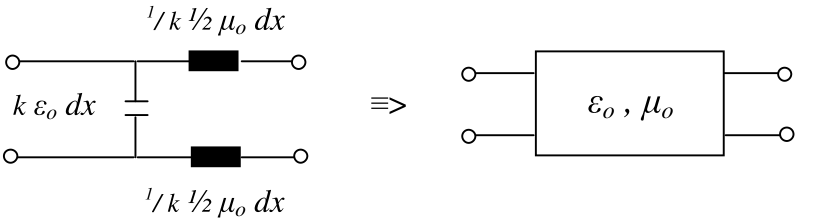
$$c_o = 1 / \sqrt{CL}$$

and because the electromagnetic wave propagation in vacuum fulfills the relationship

$$c_o = 1 / \sqrt{\varepsilon_o \mu_o}$$

where C is proportional ε_o and L is proportional μ_o, in the above illustration you can replace the capacity by the dielectric constant ε_o and the inductance by the permeability constant μ_o of the ‘empty’ space and thus you get a substitute circuit for the electromagnetic wave propagation in the ‘empty’ space as shown below, where the proportionality factor *k* is determined by the dimensions of wires, which can be chosen such that $k = 1$.[*]

[*] See the appropriate literature, K. Simonyi, Theoretical Electrical Engineering, Technical University of Budapest, 1956, et al.



Substitute element of the ‚empty' space as circuit element of an ideal wire line

For our further considerations it is of importance whether and how the relative movement between the transmitter and receiver of an electromagnetic wave and the 'empty' space takes effects on the nature and perception of the propagation of electromagnetic waves.

Because of the Michelson-Morley experiment we know that the 'empty' space is no carrier medium in the sense of ether as originally suspected. On the other hand the Michelson-Morley experiment provides the result that the 'empty' space is isotropic, that means the propagation of electromagnetic waves is from the perspective of the transmitter independent of its propagation direction and of the transmitter movement.

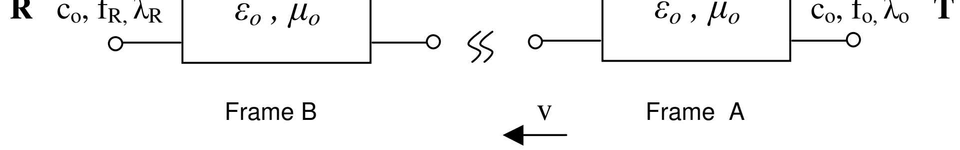
For our substitute circuit model of the 'empty' space, this means that from the perspective of the transmitter (frame A) with the transmitting frequency f_o the wavelength λ_o is solely determined by the parameters of the 'empty' space, in other words the movement of the transmitter relative to the substitute circuit of the 'empty' space, which can be assumed as static, does not affect the frequency f_o and wavelength λ_o of the transmitter.
When we consider the radiation and propagation of the electromagnetic wave from the perspective of the receiver (frame B), because of the observed Doppler effect we know that the relative speed between the transmitter and receiver has very well an effect on the perception of frequency of the electromagnetic wave, which is spreading in direction of the receiver.

When we proceed from our model of the ideal wire line as substitute for the 'empty' space and complete it with a measuring receiver, in the case of a relative motion between the transmitter and receiver the 'receive frequency' is due to the Doppler effect

$$f_R = F\{\ f_o, v, c_o\}.$$

On the other hand, because $c = 1 / \sqrt{\varepsilon_o\mu_o} = c_o$ for the propagation of electromagnetic wave in the wire line, from the perspective of the receiver it must apply that also $f_R * \lambda_R = c_o$; i.e. from the perspective of the receiver the 'receive wavelength' changes due to the relative movement between the transmitter and receiver and it is

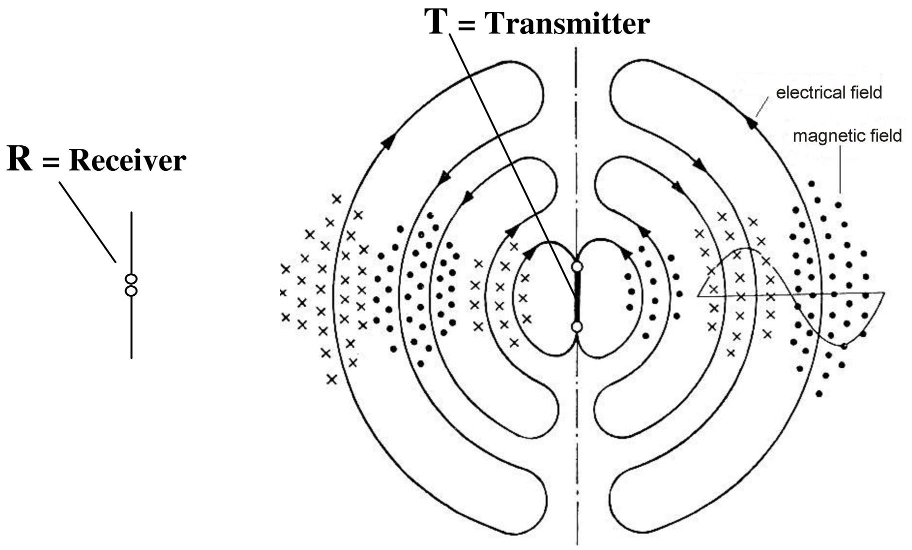
$$\lambda_R = F\{\ f_o, v, c_o\}.$$



The Einstein´s postulate of constancy of the light speed for all observers seems therefore been met, regardless of the relative speed between the observer and the light source, since in case of equality of the reference frames the observer can be assumed as stationary in accordance with the theory of relativity and the 'receive speed' of light (phase speed of light $c_R = f_R * \lambda_R = c_o$ from the perspective of the observer) is identical to the real speed of light $c = s / t = n * \lambda_R / n * T_R = \lambda_R * f_R = c_{o.}$
Therefore at this point one could be tended to finish the considerations on the question of the constancy of the speed of light.
However, as initially indicated, the objection is that all results of observations must be questioned because no observation is completely independent of the reference frame of the observer (see Doppler effect) and secondly you should always suspect behind all an uniform reality, which is independent of the arbitrariness of the reference frame of an observer.

2.2 Definition of the speed of light

With regard to light, we are dealing with an electromagnetic field, which, although wave-like, does not propagate as a kinetic energy wave through a medium, but passes through space in the form of substantial light-quanta (photons), i.e. electromagnetic quanta fields.



Electromagnetic waves of a dipole antenna

Thus the speed of light is defined as the distance in space covered by a photon, precisely by a point of the electromagnetic quantum field, during a certain time. In the case considered (see figure above), this corresponds to the spatial distance between the points of emission and reception of a field point of the radiated electromagnetic 'wave' divided by the time needed for covering this distance.

In this analysis, there is initially no need that space and time are to be considered as relativistic sizes. Rather, it must be assumed that *space and time exist as objective physical phenomena, independent of the observation of light.*
By defining a spatial reference frame independent of light observation, which is considered as static, and choosing the zero point of its coordinates so that it coincides with the - although unknown - gravitational centre of the entire system all movements in space can be described as movements within this unique reference frame and with respect to space and time we come to an uniform, non-relativistic consideration of all motions.

Furthermore we will use the terms transmitter and receiver, with all movements and emissions specified relative to the fixed reference frame, in order to come not into conflict with the theory of relativity using relativistic terms as resting or moving light source and resting or moving observer. In our case the 'objective observer' is not an observer in the sense of relativity theory (recipient of electromagnetic 'waves' or quantum fields). All spatial and temporal data of movements are from his perspective, as opposed to the viewpoint of the recipient (observer), only determined by the uniform, from now on called objective reference frame.

2.3 Determination of the speed of light

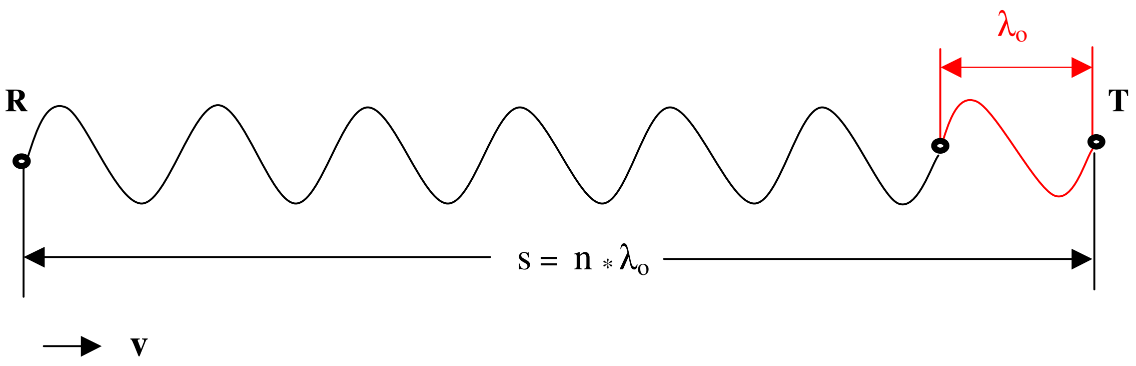
For determining the speed of light, in the following we evaluate, as defined under Section 2.2, the speed of a field point of the electromagnetic 'wave' in the first case in Section 2.3 A, when the transmitter is at rest relative to the reference frame, and in Section 2.3 B, when the transmitter is moving relatively to the referred frame, and finally in Section 2.3 C we treat the general case of constant movements of transmitter and receiver.

According to the result of the Michelson-Morley experiment we assume that the electromagnetic 'wave' does not propagate by a medium but as a substantial, wave-like electromagnetic quantum field with the speed c_o relative to the transmitter. Regarding the 'receive frequency' in the case of a relative movement between the transmitter and receiver a Doppler effect appears at the receiver also from the perspective of the 'objective observer'. For the wavelength applies that from a non-relativistic perspective it is determined anywhere in space only by the emitted wavelength λ_o of the transmitter. Because, as well known, this is not the same from the perspective of the receiver, we will determine in addition to the frequency f_R (Doppler frequency) also the 'receive wavelength' λ_R and the 'receive speed' c_R of the 'light-wave', while the referring non-relativistic objective sizes are maintained.

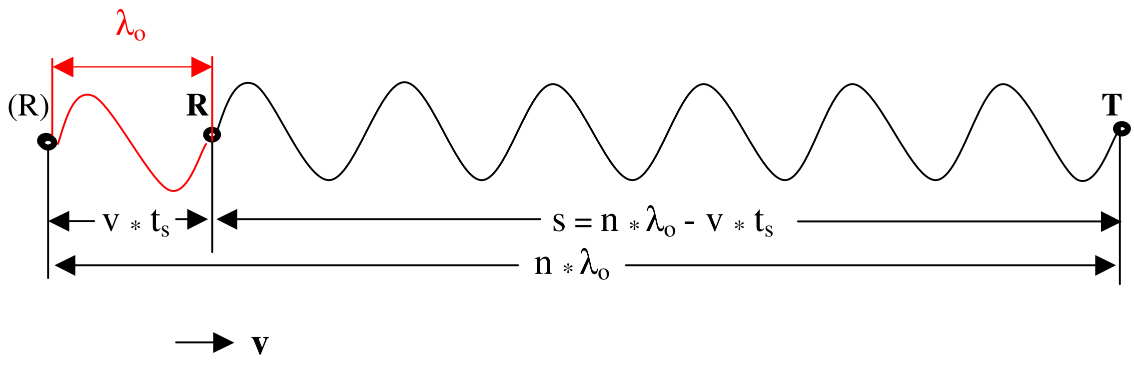
If one replaces the wave form of the light by the idea of a particle flow, λ will be the distance d of particles, f the number of particles per unit of time, and T the duration required for a particle to cover the distance d. In this case the 'receive speed' of light will be the result of the phase velocity of the particle flow $c_R = d_R / T_R = d_R * f_R = d_R * n / n * T_R = s_R / t_R$ analogous to the wave model.

A. <u>Receiver moving with a constant velocity **v** relatively to the inertial rest frame in the direction of the stationary transmitter</u>

Time t = 0:



Time $t = t_s$ = time, in which the distance **s** between transmitter and receiver is covered by the field point:



T = transmitter
R = receiver

$\boldsymbol{\lambda_o}$ = wavelength of a ´cycle´
$\mathbf{f_o}$ = frequency of the light emitted from the transmitter
$\mathbf{T_R}$ = time period of a ´cycle at the receiver
$\mathbf{f_R}$ = 'receive frequency' of the light at the receiver

speed of light:
(perspective of the
'objective observer')

$c = s / t_s = (n * \lambda_o - v * t_s) / t_s = n * \lambda_o / t_s - v = n * \lambda_o / n * T_R - v$
$= \lambda_o / T_R - v = \lambda_o * f_R - v$

The frequency of the light arriving at the receiver changes proportionally to the increase in the relative speed between the transmitter and receiver (Doppler effect), namely:

$f_R / f_o = (f_o + \Delta f) / f_o = (c_o + v) / c_o = 1 + v / c_o$ and
$f_R = f_o (1 + v / c_o)$
i.e. $c = \lambda_o * f_o (1 + v / c_o) - v = c_o (1 + v / c_o) - v = c_o$

The vacuum speed of light emitted from the stationary transmitter is independent of the receiver moving with the speed v in direction of the transmitter and so equal to the vacuum speed of light c_o.

'receive frequency':
(perspective of the
receiver)

If the receiver moves with constant velocity v in direction of the stationary transmitter, the 'receive frequency' from the perspective of the receiver will be $f_R = f_o (1 + v / c_o)$

'receive wavelength':
(perspective of the
receiver)

The 'receive wavelength' λ_R from the perspective of the receiver is the result of the relation $n * \lambda_R = s_R = n * \lambda_o - v * t_s = n * \lambda_o - v * n * T_R$; i.e. $\lambda_R = \lambda_o - v * T_R = \lambda_o - v * 1 / f_R = (\lambda_o * f_R - v) / f_R = [\lambda_o * f_o * (1 + v / c_o) - v] / f_R = [c_o + v - v] / f_R = c_o / f_R$

If the receiver moves with a constant speed v in direction of the stationary transmitter, the 'receive wavelength' will be $\lambda_R = c_o / f_R$.

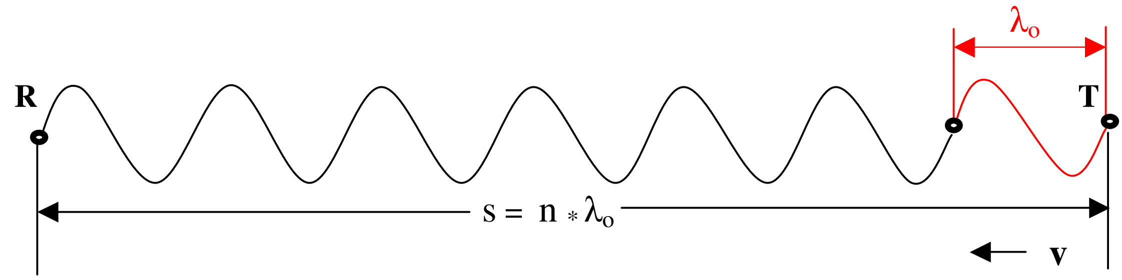
'receive speed' of light:
(perspective of the
receiver)

If the receiver moves with a constant speed v in direction of the stationary transmitter, the 'receive speed' of light will be $c_R = f_R * \lambda_R = c_o$.

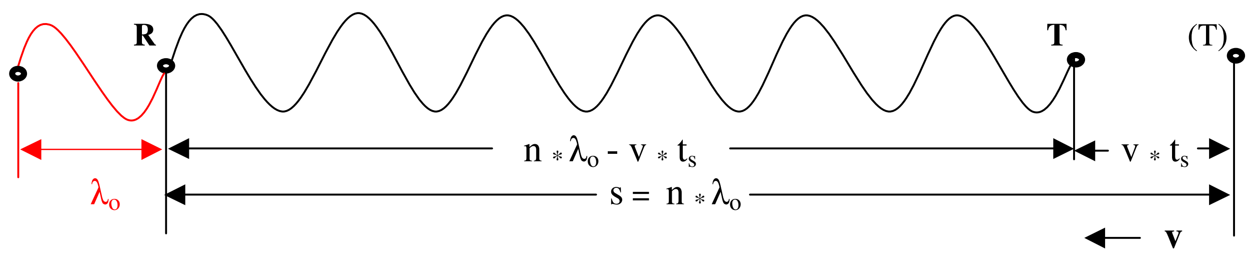
Especially in this example can be nicely shown that the 'receive speed' of light c_R is not the real impact velocity of a photon or of a point of the electromagnetic quantum field at the receiver, but only the phase speed of light observable from the perspective of the receiver. If the light with the wavelength λ_o or with the particle distance $d = \lambda_o$, which parameter objectively does not change until the time of arriving at the receiver, would impinge on the receiver with the relative speed c_o, it is obvious that in our case it should not at all result in a Doppler effect. When space and time are regarded as non-relativistic, the necessary condition for the occurrence of the Doppler effect is in fact that from an objective perspective (perpective of the stationary transmitter) the field points of the radiated electromagnetic 'wave' or of the individual quanta of light of a particle flow must impinge on the receiver with the relative speed $c_o \pm v$.

B. Transmitter moving with a constant velocity **v** relatively to the inertial rest frame in the direction of the stationary receiver

Time $t = 0$:



Time $t = t_s$ = time, in which the distance **s** between transmitter and receiver is covered by the field point:



T = transmitter	λ_o = wavelength of a ´cycle´
R = Receiver	f_o = frequency of the light emitted from the transmitter
	T_R = time period of a ´cycle at the receiver
	f_R = 'receive frequency' of the light at the receiver

speed of light: (perspective of the 'objective observer')

$c = s / t_s = n * \lambda_o / n * T_R = \lambda_o / T_R = \lambda_o * f_R$

Due to the Doppler effect is $f_R = f_o\,(1 + v / c_o)$;
i.e. $c = \lambda_o * f_o\,(1 + v / c_o) = c_o\,(1 + v / c_o) = c_o + v$

The vacuum light speed of the transmitter moving with the speed v relatively to the stationary receiver and thus relatively to the rest frame is from the perspective of the 'objective observer' moving with the speed $c_o + v$, i.e. v greater than the vacuum light speed c_o of the stationary transmitter, and thus constant c_o relative to the moving transmitter.

‘receive frequency’: (perspective of the receiver)

If the transmitter moves with constant velocity v in direction of the stationary receiverer, the ‘receive frequency’ from the perspective of the receiver will be $f_R = f_o (1 + v / c_o)$

‘receive wavelength’: (perspective of the receiver)

The ‘receive wavelength’ λ_R from the perspective of the receiver is analog to case B the result of the relation $n * \lambda_R = s_R = n * \lambda_o - v * t_s = n * \lambda_o - v * n * T_R$; i.e. $\lambda_R = \lambda_o - v * T_R = \lambda_o - v * 1 / f_R = (\lambda_o * f_R - v) / f_R = [\lambda_o * f_o * (1 + v / c_o) - v] / f_R = [c_o + v - v] / f_R = c_o / f_R$

If the transmitter moves with a constant speed v in direction of the receiver, the ‘receive wavelength’ at the stationary receiver will be $\lambda_R = c_o / f_R$.

‘receive speed’ of light: (perspective of the receiver)

If the transmitter moves with a constant speed v in direction of the stationary receiver, the ‘receive speed’ of light from the perspective of the receiver will be $c_R = f_R * \lambda_R = c_o$.

C. General case of constant movements of transmitter and receiver:

Based on the previous considerations, below we generalize our results for the case of different, but constant movements of the transmitter and receiver.

speed of light: (perspective of the ‘objective observer’)

$\pm \mathbf{v_T}$ = velocity of the transmitter
$\pm \mathbf{v_R}$ = velocity of the receiver

Depending on the directions of movements of the transmitter and receiver the following relations apply:

a) Movements of the transmitter and receiver in direction of propagation of light

$c = s / t_s = (n * \lambda_o + v_R * t_s) / t_s = n * \lambda_o / t_s + v_R = n * \lambda_o / n * T_R + v_R = \lambda_o / T_R + v_R = \lambda_o * f_R + v_R = \lambda_o * f_o [1 + (v_T - v_R) / c_o] + v_R = c_o + v_T$

b) Movements of the transmitter and receiver in the opposite direction of propagation of light

$c = s / t_s = (n * \lambda_o - v_R * t_s) / t_s = n * \lambda_o / t_s - v_R = n * \lambda_o / n * T_R - v_R = \lambda_o / T_R - v_R = \lambda_o * f_R - v_R = \lambda_o * f_o [1 - (v_T - v_E) / c_o] - v_E = c_o - v_T$

c) Movement of the transmitter in direction and movement of the receiver in the opposite direction of propagation of light

$c = s / t_s = (n * \lambda_o - v_R * t_s) / t_s = n * \lambda_o / t_s - v_R = n * \lambda_o / n * T_R - v_R = \lambda_o / T_R - v_R = \lambda_o * f_R - v_R = \lambda_o * f_o [1 + (v_T + v_E) / c_o] - v_R = c_o + v_T$

d) Movement of the transmitter in the opposite direction and movement of the receiver in direction of propagation of light

$c = s / t_s = (n * \lambda_o + v_R * t_s) / t_s = n * \lambda_o / t_s + v_R = n * \lambda_o / n * T_R + v_R =$
$\lambda_o / T_R + v_R = \lambda_o * f_R + v_R = \lambda_o * f_o [1 - (v_T + v_R) / c_o] + v_R = c_o - v_T$

The vacuum light speed of the transmitter moving with the speed v_T in or in the opposite direction of propagation of light is from the perspective of the 'objective observer' greater respectivly smaller than the vacuum light speed c_o of the stationary transmitter. It is independent of the speed of the receiver.

'receive frequency': (perspective of the receiver)

Depending on the directions of movements of the transmitter and receiver the following relations apply:

a) Movements of the transmitter and receiver in direction of propagation of light

$f_R = f_o [1 + (v_T - v_R) / c_o]$

b) Movements of the transmitter and receiver in the opposite direction of propagation of light

$f_R = f_o [1 - (v_T - v_R) / c_o]$

c) Movement of the transmitter in direction and movement of the receiver in the opposite direction of propagation of light

$f_R = f_o [1 + (v_T + v_R) / c_o]$

d) Movement of the transmitter in the opposite direction and movement of the receiver in direction of propagation of light

$f_R = f_o [1 - (v_T + v_R) / c_o]$

The 'receive frequency' f_R at the receiver is dependent on the relative speed between the transmitter and receiver and their directions of movements in relation to the propagation of light (temporal Doppler effect).

'receive wavelength': (perspective of the receiver)

Depending on the directions of movements of the transmitter and receiver the following relations apply:

a) Movements of the transmitter and receiver in direction of propagation of light

$n * \lambda_R = s_R = n * \lambda_o - v_T * t_s + v_R * t_s = n * \lambda_o - v_T * n * T_R + v_R * n * T_R$
$\lambda_R = \lambda_o - v_T * T_R + v_R * T_R = \lambda_o - (v_T - v_R) / f_R = [\lambda_o * f_R - v_T + v_R] / f_R =$
$[\lambda_o * f_o [1 + (v_T - v_R) / c_o] - v_T + v_R] / f_R = [c_o + v_T - v_R - v_T + v_R)] / f_R$
$\lambda_R = c_o / f_R$

b) Movements of the transmitter and receiver in the opposite direction of propagation of light

$n * \lambda_R = s_R = n * \lambda_o + v_T * t_s - v_R * t_s = n * \lambda_o + v_T * n * T_R - v_R * n * T_R$
$\lambda_R = \lambda_o + v_T * T_R - v_R * T_R = \lambda_o + (v_T - v_R) / f_R = [\lambda_o * f_R + v_T - v_R] / f_R =$
$[\lambda_o * f_o [1 - (v_T - v_R) / c_o] + v_T - v_R] / f_R = [c_o - v_T + v_R + v_T - v_R)] / f_R$
$\lambda_R = c_o / f_R$

c) Movement of the transmitter in direction and movement of the receiver in the opposite direction of propagation of light

$n * \lambda_R = s_R = n * \lambda_o - v_T * t_T - v_R * t_s = n * \lambda_o - v_T * n * T_R - v_R * n * T_R$
$\lambda_R = \lambda_o - v_T * T_R - v_R * T_R = \lambda_o - (v_T + v_R) / f_R = [\lambda_o * f_R - v_T - v_R] / f_R =$
$[\lambda_o * f_o [1 + (v_T + v_R) / c_o] - v_T - v_R] / f_R = [c_o + v_T + v_R - v_T - v_R)] / f_R$
$\lambda_R = c_o / f_R$

d) Movement of the transmitter in the opposite direction and movement of the receiver in direction of propagation of light

$n * \lambda_R = s_R = n * \lambda_o + v_T * t_s + v_R * t_s = n * \lambda_o + v_T * n * T_R + v_R * n * T_R$
$\lambda_R = \lambda_o + v_s * T_R + v_R * T_R = \lambda_o + (v_T + v_R) / f_R = [\lambda_o * f_R + v_T + v_R] / f_R$
$= [\lambda_o * f_o [1 - (v_T + v_R) / c_o] + v_T + v_R] / f_R = [c_o - v_T - v_R + v_T + v_R)] / f_R$
$\lambda_R = c_o / f_R$

The 'receive wavelength' λ_E from the perspective of the receiver is dependent on the relative speed between the transmitter and receiver and their directions of movements in relation to the propagation of light (spatial Doppler effect).

'receive speed' of light: (perspective of the receiver)

The 'receive speed' of light $c_R = \lambda_R * f_R$ is in all cases equal to the vacuum speed of light c_o.

2.4 Summary of the previous considerations on the speed of light

The vacuum speed of light relative to the transmitter is always constant c_o independent of the movement of the transmitter (Michelson-Morley experiment).
From the Maxwell theory can be deduced that the 'receive speed' of light in the 'empty' space (phase speed of light $c_R = \lambda_R * f_R$ from the perspective of the receiver) is also always equal to the vacuum speed of light c_o regardless of the relative speed between the transmitter and receiver.
While 'transmit- and receive frequency' and 'transmit- and receive wavelength' as a function of the relative speed between the transmitter and receiver are different (temporal and spatial Doppler effect), this is under the premise that space and time are of an objective, non-relativistic nature not the same for the absolute speed of light (speed of a single point of the electromagnetic 'wave' or of a single photon relative to an inertial rest frame) from the perspective of an 'objective observer'.
Einstein´s postulate of the constancy of the light speed for all observers is therefore for the present only valid for the observable 'receive speed' of light (phase velocity of the received light).
Thus it is still not excluded that there is a preferred inertial frame, which allows to interprete all phenomena of the propagation of light processes uniformly regardless of the relativistic view of the observer (recipient).

By establishing an unique reference frame, based on the classical views of space and time and presumed as an objective frame, we come to the following conclusions when determining the speed of light:

1. The vacuum speed of light emitted from a stationary transmitter is always constant c_o and independent of the receiver and its movement within the uniform, stationary and as objective regarded reference frame.

2. However, when we determine the vacuum speed of light emitted from a moving transmitter, we find that the speed of light is changing corresponding to the speed of the transmitter within the uniform, stationary reference frame.

3. For the 'receive speed' of light (phase velocity of light from the perspective of the receiver) it applies that even, when we introduce the uniform, stationary and as objective regarded reference frame, it is always constant c_o in the 'empty' space for all considered cases regardless of the movements of the transmitter and receiver.
For the determination of the impact velocity of light at the receiver (relative speed between the receiver and the field points of the electromagnetic 'wave' or of the individual quanta fields of a particle flow respectively) it applies that from the perspective of the objective reference frame the current speed of the transmitter and receiver relative to the objective reference frame must be taken into account. A Doppler effect at the receiver occurs in this case only, when the relative speed between the receiver and the relevant field points of the emitted electromagnetic 'wave' or of the individual quanta fields of the flow of particles differ from c_o.

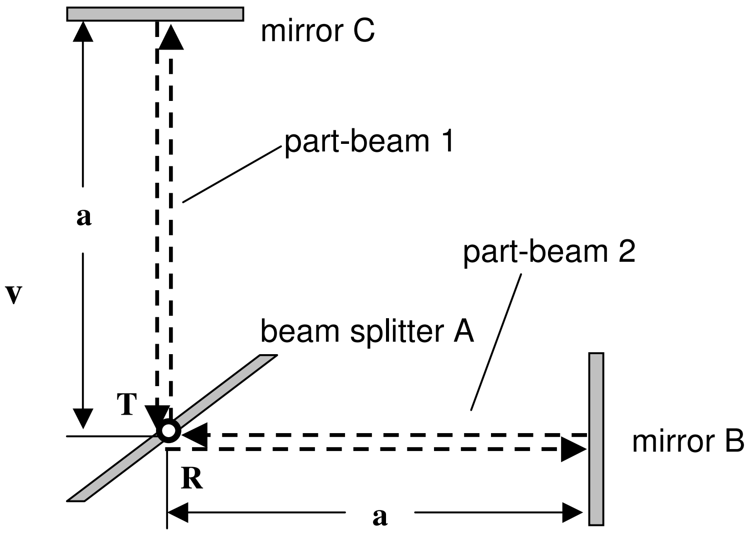
There is therefore no absolute constancy of the vacuum speed of light within the as objective regarded, uniform reference frame. The constancy of the 'receive speed' of light in the 'empty' space can also be demonstrated by maintaining the temporal and spatial dimensions of our objective reference frame and may not be equated with the absolute vacuum speed of light (speed of a single photon or of a field point of the electromagnetic 'wave' respectively).

In the case of a relative movement between the transmitter and receiver it occurs not only a temporal, but also a spatial Doppler effect at the receiver. However, this relativistic view of the recipient (observer) is restricted, because the recipient solely on the basis of the observable physical quantities, namely the 'receive frequency' f_R, the 'receive wavelength' λ_R and the 'receive speed' of light c_R, neither can distinguish between the objectively different movements of the transmitter and receiver as shown in Section 2.3 nor can make a statement about the radiated frequency f_o or emitted wavelength λ_o.
On the other hand, the uniform, as objective regarded reference frame, allows not only a differentiated approach of the objectively different motions as shown in Section 2.3, it also provides an interpretation of the spatial Doppler effect occurring from the perspevtive of the observer (recipient) and thus an explanation for the always constant 'receive speed' of light $c_E = c_0$. It is therefore not inconsistent with the relevant results derived from Maxwell's theory in chapter 2.1.

2.5 The Michelson-Morley experiment
(Under the condition that the speed of propagation of light in accordance with the considerations in Section 2.3 A - C depends on the speed of the transmitter within the stationary reference frame)

The fact that the relativization of space and time is not necessary also with respect to the Michelson-Morley experiment, the result of which was the development of the Special Theory of Relativity, will be shown below by determining the speed of propagation of light in consideration of the relative motion of the transmitter to a spatial reference frame at rest.

a) <u>Transmitter and receiver are at rest relative to the reference frame:</u>



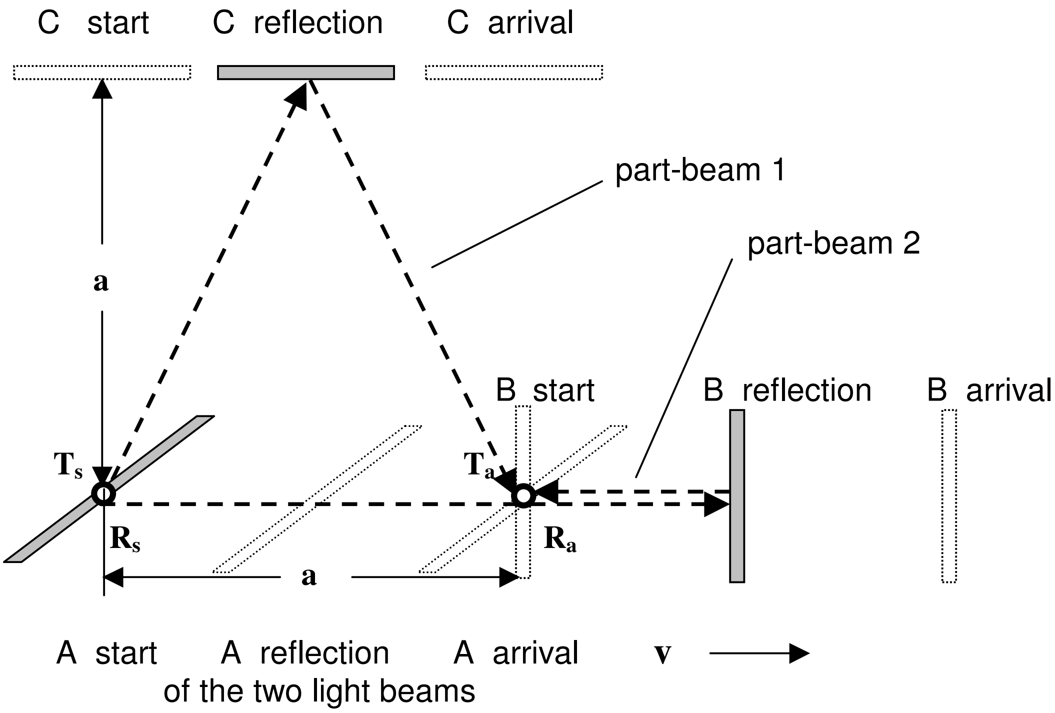
S = transmitter
E = receiver

a = distance between transmitter and receiver

speed of light: $c = s / t_s = 2a / t_s = c_o$

The vacuum speed of light for both beam paths between transmitter, mirrors B or C and the receiver is c_o. The length of each beam path is $s = 2a$. The observed run time t_s is the same in both cases.

b) <u>Transmitter and receiver are moving with the speed **v** within the stationary reference frame in direction of the part-beam 2 to mirror B:</u>



T_s = transmitter starting
T_a = transmitter arriving
R_s = receiver starting
R_a = receiver arriving

v = velocity of the total test device in the space
a = distance between transmitter and mirror

1. speed of the photon between transmitter, mirror C und receiver:

$$c_1 = s_1 / t_{s1} = 2 \sqrt{a^2 + (v * t_{s1} / 2)^2} \; / t_{s1} = \sqrt{4 a^2 / t_{s1}^2 + v^2}$$

2. speed of the photon between transmitter, mirror B und receiver:

After the aforesaid, the photon in direction of the mirror B or from mirror B back to the receiver has different speeds c_2' and c_2''.

$$c_2' = s_2' / t_{s2}' = (a + v * t_{s2}') / t_{s2}' = a / t_{s2}' + v = c_o + v \; ; \text{ i.e. } t_{s2}' = a / c_o$$
$$c_2'' = s_2'' / t_{s2}'' = (a - v * t_{s2}'') / t_{s2}'' = a / t_{s2}'' - v = c_o - v \; ; \text{ i.e. } t_{s2}'' = a / c_o$$

It follows $t_{s2} = t_{s2}' + t_{s2}'' = 2a / c_o$; because $t_{s1} = t_{s2}$ we find under 1.:

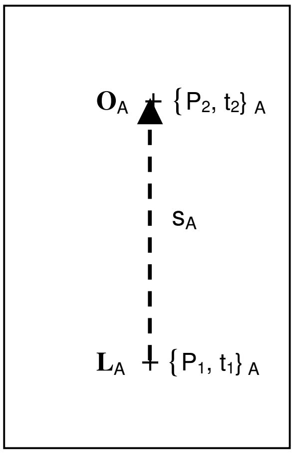
$c_1 = s_1 / ts_1 = \sqrt{c_o^2 + v^2}$; i.e. the speed of light beam 1 is composed of the vacuum speed of light c_o in direction of mirror C and the relative velocity v in direction of mirror B.

Thus the Michelson-Morley experiment is clearly explained without the requirement of relativization of space and time under the condition that the speed of light in accordance with the considerations in Section 2.3 and 2.4 depends on the speed of the transmitter (light source) relative to the objective reference frame.

3. Relativity and objectivity of space and time

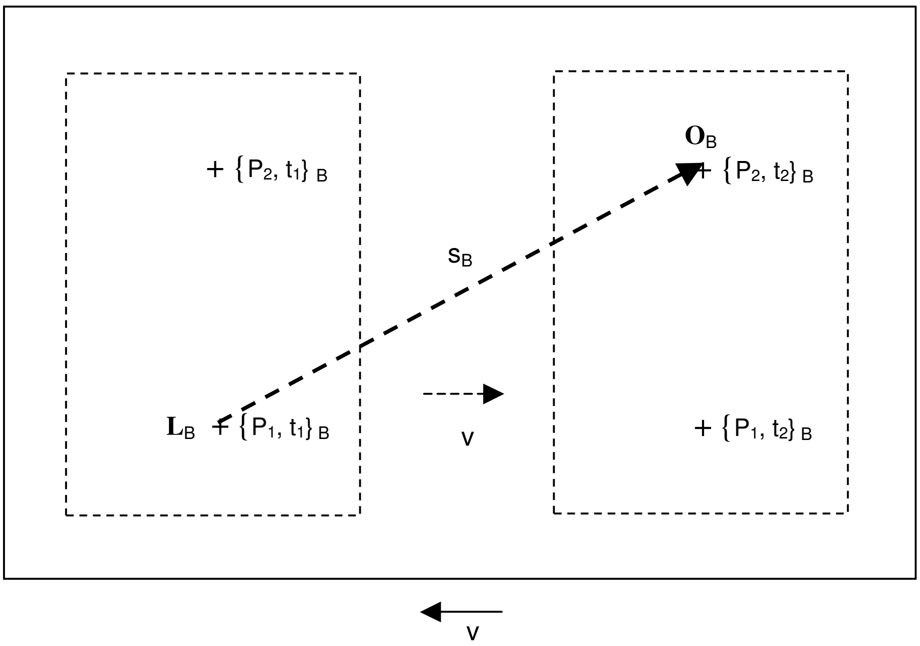
3.1 Space and time in accordance with the theory of relativity

Let´s consider another example of our two event points $\{P_1, t_1\}$and $\{P_2, t_2\}$ of Section 1 initially from the perspective of the reference frame A and expand our thought experiment, as follows:
Under vacuum conditions there is on point P_1 a light source L, which emits a light beam at the time t_1 in direction of P_2, which there impinges at the time t_2 on an observer O.



Frame A

Then we look at the same event from the perspective of frame B, which is moving with the constant speed v relatively to frame A.



Frame B

According to the theory of relativity the speed of light for the observers of both reference frames is *absolutely* constant; i.e. also the speed of a field point of the electromagnetic quantum field is always constant c_o.

In frame A this means that $$s_A / (t_2 - t_1)_A = s_A / t_A = c_o \qquad (1)$$

and in frame B that $$s_B / (t_2 - t_1)_B = s_B / t_B = c_o \qquad (2)$$

By equating the equations (1) and (2) and substituting s_A and s_B by $f\{t_A\}$ and $f\{t_B\}$ you obtain with the help of the equation established already in Section 1

$$s_B = \sqrt{s_A^2 + [v\,(t_2 - t_1)_B]^2}$$

according to Einstein´s theory of relativity the well known relation

$$t_B = t_A \cdot 1 / \sqrt{1 - (v / c_o)^2} = t_A \cdot \gamma \quad \text{or}$$

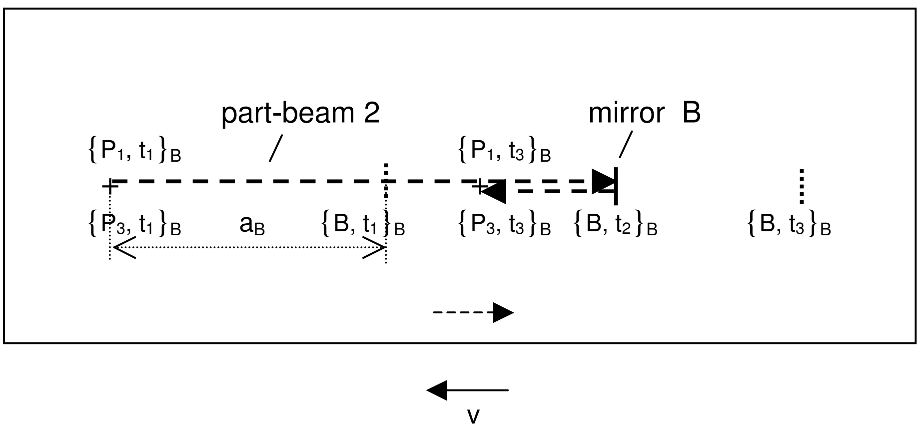
$$t_A = t_B \cdot \sqrt{1 - (v / c_o)^2} = t_B \cdot 1 / \gamma$$

$$\text{with} \quad \gamma = 1 / \sqrt{1 - (v / c_o)^2} = \text{relativity factor}$$

Accordingly the time in the frames A and B passes differently as a function of the relative velocity v between the two frames, i.e. in our case in frame A the time passes by the relativity factor γ more slowly in comparison with the *own time* of the observer O_B for the same event.

Because according to the theory of relativity all reference frames are equally entitled and each observer can regard himself at rest relative to the observed event, it applies for the same event in frame B that the time passes more slowly for the observer of frame B by the relativity factor γ in comparison with the *own time* of the observer O_A or in other words, in the frame moving relatively to the observer there is a time-delay (*time dilatation*) by the relativity factor γ.

As shown below, this leads to the conclusion that in accordance with the relativity theory for both observers also the space in direction of the relative motion is different.
In this regard, we once again consider the Michelson-Morley experiment according to Section 2.5.



Frame B

The run time of part-beam 2 between the transmitter at the starting point $\{P_1, t_1\}_B$ and the receiver upon arrival $\{P_3, t_3\}_B$ is composed of the part-time t'_{B2} for the way there and the part-time t''_{B2} for the way back due to reflection by the mirror. From the perspective of the observer considered as stationary in reference frame B it follows in accordance with the theory of relativity:

$$t'_{B2} \cdot c_o = a_B + v \cdot (t_2 - t_1) = a_B + v \cdot t'_{B2} \qquad (1)$$

$$t''_{B2} \cdot c_o = a_B - v \cdot (t_3 - t_2) = a_B - v \cdot t''_{B2} \qquad (2)$$

From the two equations one obtains the total run time of part-beam 2 by resolving t'_{B2} and t''_{B2} and by addition of the two times.

$$t_{B2} = a_B \cdot 1 / (c_o - v) + a_B \cdot 1 / (c_o + v)$$

However, the total run time of part-beam 1 and part-beam 2 in the Michelson-Morley experiment is equal from the perspective of an observer both in frame A as in frame B, because the two beams simultaneously arrive at the receiver for both observers. So it is

$$t_{B1} = t_{B2} \text{ and } t_{A1} = t_{A2}$$

With the relation determined at the beginning of Section 3.5 for a beam vertical to the direction of motion of the two reference frames analogous to part-beam 1 in the Michelson-Morley experiment

$$t_{B1} = t_{A1} \cdot 1 / \sqrt{1 - (v / c_o)^2} = t_{A1} \cdot \gamma$$

it follows that this relation must apply also for part-beam 2, i.e.

$$t_{B2} = t_{A2} \cdot 1 / \sqrt{1 - (v / c_o)^2} = t_{A2} \cdot \gamma$$

As $t_{A2} = t_{A1} = 2\, a_A / c_o$, it is $\quad t_{B2} = t_{A2} \cdot \gamma = (2\, a_A / c_o) \cdot \gamma = a_B \cdot 1 / (c_o - v) + a_B \cdot 1 / (c_o + v)$

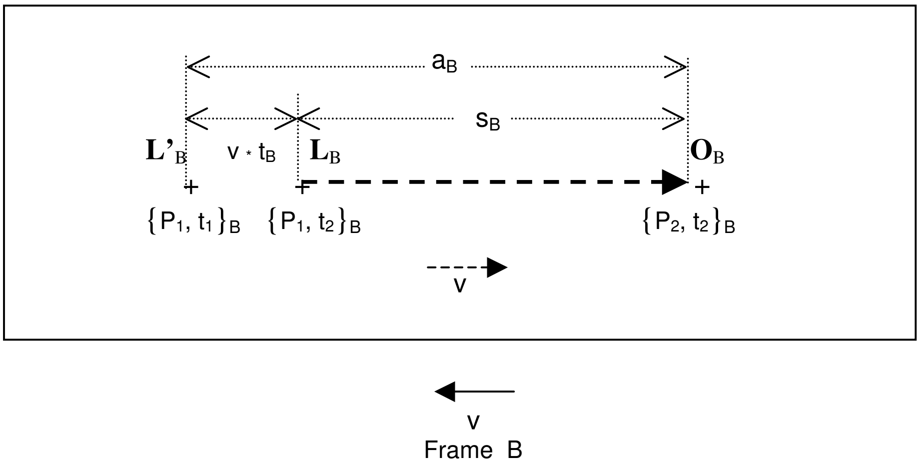
By resolving a_B from the latter equation we obtain the relation

$$a_B = a_A \cdot \sqrt{1 - (v / c_o)^2} = a_A \cdot 1 / \gamma$$

As for considering the time it applies also here that all reference frames are equally entitled according to the theory of relativity and that each observer can regard himself as stationary compared to the observed event. The space extension in direction of motion of the reference frames, which are moving relatively to each other, is therefore by the relativity factor γ greater within the frame regarded as stationary than in the moving frame, i.e. in the frame moving relatively to the observer a *space compression* by the relativity factor γ occurs in direction of motion.

Under this premise of the theory of relativity, now we will consider again the Doppler effect occurring at the observer, when there is a relative speed between light source (transmitter) and observer (receiver). In the simplest case the light source is moving in direction of propagation of light with the constant speed v towards the observer at rest in relation to frame B. Then, we look at the case that the light source, under otherwise identical conditions, is moving away from the observer, and finally at the general case that the direction of movement between light source and the observer is not identical with the direction of propagation of light.

a) <u>The light source is moving with the velocity **v** towards the observer:</u>



For the observer of frame B is

$$s_B / t_B = c_o = (a_B - v \cdot t_B) / t_B = (a_A \cdot 1 / \gamma - v \cdot t_B) / t_B$$

With $a_A = t_A \cdot c_o$ follows $\quad (t_A \cdot c_o \cdot 1 / \gamma - v \cdot t_B) / t_B = c_o$

Then t_B is $\quad t_B = t_A \cdot [1 / (1 + v / c_o)] \cdot 1 / \gamma$

with $t_B = n \cdot T_B$ resp. $t_A = n \cdot T_A$ and $1/ T_A = f_A = f_o$ we obtain

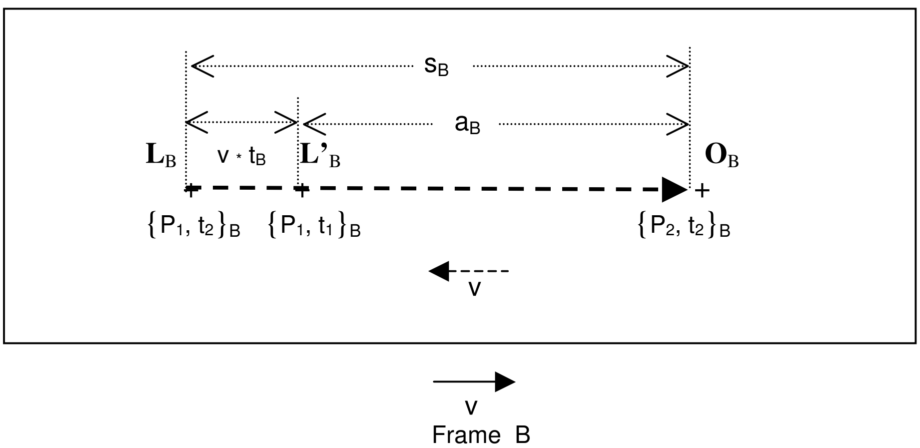
the Doppler frequency $\quad f_B = f_o \cdot (1 + v / c_o) \cdot \gamma$

For the wavelength of the light received by the observer we find with

$s_B = n \cdot \lambda_B = t_B \cdot c_o = n \cdot T_B \cdot c_o = n \cdot (1 / f_B) \cdot c_o$ and therefore $f_B \cdot \lambda_B = f_A \cdot \lambda_A = f_o \cdot \lambda_o = c_B = c_A = c_o$

the Doppler wavelength $\quad \lambda_B = \lambda_o \cdot 1/ [(1 + v / c_o) \cdot \gamma]$

b) <u>The light source is moving with the velocity **v** away from the observer:</u>



For the observer of frame B is

$$s_B / t_B = c_o = (a_B + v \cdot t_B) / t_B = (a_A \cdot 1/\gamma + v \cdot t_B) / t_B$$

With $a_A = t_A \cdot c_o$ follows $(t_A \cdot c_o \cdot 1/\gamma + v \cdot t_B) / t_B = c_o$

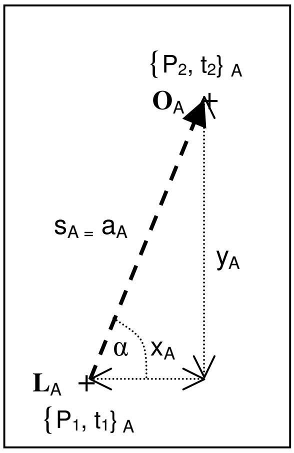
Then t_B is $t_B = t_A \cdot [1 / (1 - v / c_o)] \cdot 1/\gamma$

and with $t_B = n \cdot T_B$ resp. $t_A = n \cdot T_A$ and $1/T_A = f_A = f_o$ we obtain

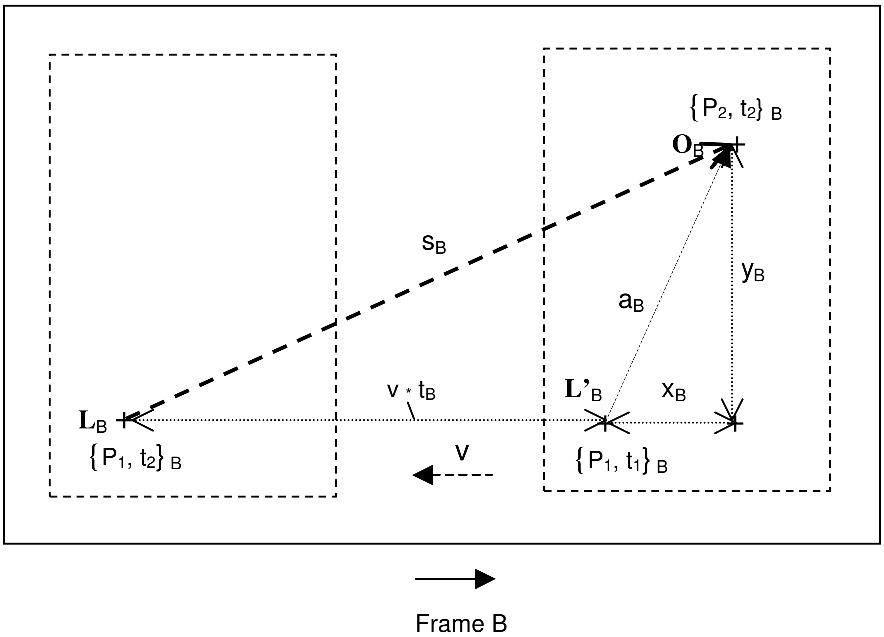
the Doppler frequency $f_B = f_o \cdot (1 - v / c_o) \cdot \gamma$ and analogous to b)

the Doppler wavelength $\lambda_B = \lambda_o \cdot 1/[(1 - v / c_o) \cdot \gamma]$

c) General case of the relative motion between light source and observer:



Frame A



Frame B

For the observer of frame B is

$$s_B = \sqrt{(x_B + v \cdot t_B)^2 + y_B^2}$$

With $s_B / t_B = c_o$ and therefore $t_B = s_B / c_o$ follows

$$t_B \cdot c_o = \sqrt{(x_B + v \cdot t_B)^2 + y_B^2}$$

$$t_B^2 \cdot c_o^2 = (x_B + v \cdot t_B)^2 + y_B^2$$

With $y_B = y_A = s_A \cdot \sin\alpha = t_A \cdot c_o \cdot \sin\alpha$ and $x_B = x_A \cdot 1/\gamma = s_A \cdot \cos\alpha \cdot 1/\gamma = t_A \cdot c_o \cdot \cos\alpha \cdot 1/\gamma$ follows

$$t_B^2 \cdot c_o^2 = (t_A \cdot c_o \cdot \cos\alpha \cdot 1/\gamma + v \cdot t_B)^2 + t_A^2 \cdot c_o^2 \cdot \sin^2\alpha$$

By resolving t_B of the quadratic equation you obtain

$$t_B = t_A \cdot \gamma\, [1 + (v / c_o) \cdot \cos\alpha]$$

and with $t_B = n \cdot T_B$ resp. $t_A = n \cdot T_A$ and $1/ T_A = f_A = f_o$ and depending on the sign of the relative movement v finally follows

the general formula for the relativistic Doppler frequency

$$f_B = f_o \cdot 1/\gamma \cdot 1/ [1 \pm (v / c_o) \cdot \cos\alpha]$$

3.2 Objectivity of space and time versus relativity theory

As shown in Section 3.1, the derivation of the relativity of space and time is mathematically conclusive in accordance with the requirements of the special theory of relativity. But the crucial requirement of *absolute* constancy of the speed of light is not essential to explain the observable constancy of the 'receive speed' of light in accordance with previous considerations.
However, the situation is different with the relativistic Doppler effect derived in Section 3.1, which should not occur under the assumption that space and time can be regarded as non-relativistic and objective.

Let´s consider therefore once again the results in Section 2.3 and 3.1:

a) In the case that both the transmitter (light source) and the receiver (observer) are moving in direction of propagation of light with the speed v towards each other, we get

the non-relativistic Doppler frequency $f_R = f_o (1 + v / c_o)$
and the relativistic Doppler frequency $f_B = f_o (1 + v / c_o) \cdot \gamma$

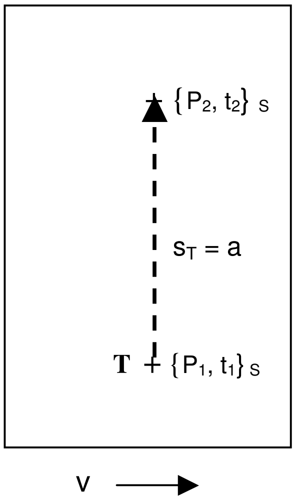
b) In the case that both the transmitter (light source) and the receiver (observer) are moving in direction of propagation of light with the speed v away from each other, we get

the non-relativistic Doppler frequency $f_R = f_o (1 - v / c_o)$
and the relativistic Doppler frequency $f_B = f_o (1 - v / c_o) \cdot \gamma$

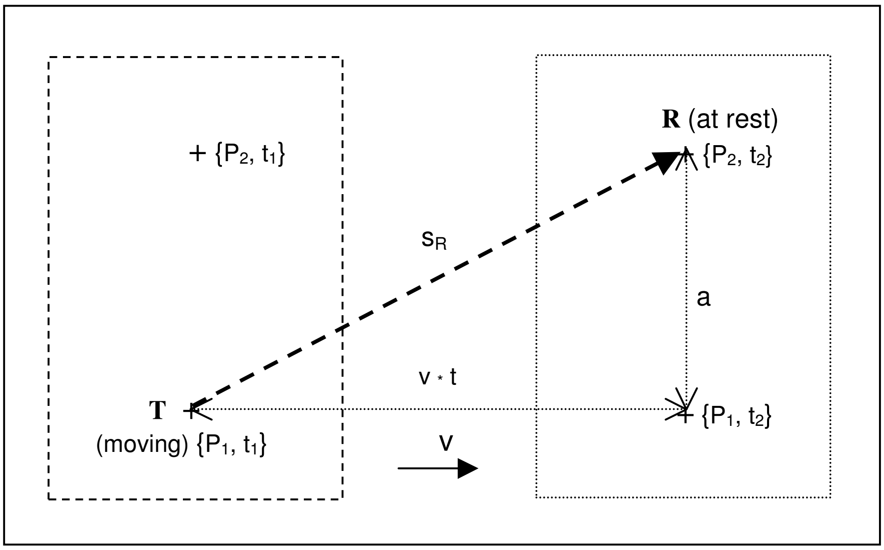
c) In the special case that the transmitter (light source) and receiver (observer) are moving towards one another with the speed v transverse to the direction of propagation of light, a transversal Doppler effect occurs according to the theory of relativity

with the relativistic Doppler frequency $\quad f_B = f_o * 1/\gamma$

Since we have not studied yet the last case on the assumption that space and time can be regarded as non-relativistic, we want to do this below.



Reference frame of the transmitter



(objective) rest frame of the receiver

Within the objective reference frame of the receiver is

$$s_R = \sqrt{a^2 + [v\,(t_2 - t_1)]^2} = \sqrt{a^2 + (v * t\,)^2}$$

This means that a field point of the emitted electromagnetic 'wave' or of the emitted photon respectively covers the objective distance s_R in the time t.
As already shown in Section 2.5 and in connection with the non-relativistic interpretation of the Michelson-Morley experiment, the speed of a field point of the electromagnetic 'wave' or of the individual photon respectively then is

$$c = \sqrt{a^2 + (v * t\,)^2}\ / t = \sqrt{a^2 / t^2 + v^2} = \sqrt{c_o^2 + v^2}$$

Because the relative velocity v has a constant value according to pre-condition, and as long as a as the parallel distance between the receiver (observer) and the transmitter (light source) is constant, also c and t have discrete constant values, in other words, for a certain speed v and a certain distance a it can exist even just a *single* fixed time t, in which a field point of the electromagnetic 'wave' or a single photon can be observed.

This time t, in which the field point covers the distance between the event points $\{P_1, t_1\}$ and $\{P_2, t_2\}$, is in both reference frames, how easily can be reviewed,

$$t = a / c_o$$

Thus, in our case a transversal Doppler effect can not occur at the receiver. In accordance with the non-relativistic theory a Doppler effect can only be observed during relative movements in axial direction of propagation of light.

This finding coincides with the at the Johannes Kepler University of Linz in 2003 by Univ. Dipl.-Ing. Dr. Hartwig Thim guided experimental proof of the non-occurrence of a transversal relativistic Doppler effect with the help of a micro-wave interferometer.*

As the two theories differ regarding the presence of a transversal Doppler effect and also in terms of the equations for determining the Doppler frequency or Doppler wavelength of the Doppler effect observable in direction of propagation of light, the question, whether the change in time and space according to the relativity theory or wether the change in the impact velocity of the field points of the radiated electromagnetic 'wave' or of the photons according to the non-relativistic theory are causal for the Doppler effect, is crucial for the correctness of the Special Relativity Theory and all of their conclusions.

The postulate of absolute constancy of the light speed and the resulting change of space (space compression) and time (time dilatation) for the observer relative to a moving event is not sufficient to demonstrate the correctness of this theory, as long as only the 'receive speed' of light (phase speed of light from the perspective of the receiver) can be measured and not the absolute speed of a single photon, or more accurately the speed of a field point of the radiated electromagnetic quanta field, relative to a fixed reference point independent of the relative speed of the light source (transmitter).

* H.W.Thim, „Absence of the transverse Doppler shift at microwave frequencies", *IEEE Transactions on Instrumentation and Measurement*, Vol. 52, No. 5, pp. 1660 - 1665, October 2003, ISSN 0018-9456

4. Mass, momentum and energy of a photon

Even for the determination of mass, momentum and energy of a photon we have to distinguish between the theory of relativity and a theory of objective movements based on the non-relativistic outlook of space and time (subsequently called 'theory of objectivity') due to the previous considerations on the speed of light.

4.1 Mass, momentum and energy of a photon according to the theory of relativity

From the postulate of relativity theory for absolute constancy of the speed of light for all observers derives not only that time and space depend on the relative velocity between observer and observed object, but also the mass of a substance has from the perspective of the observer different values depending on the movement. (The derivation is omitted here.)

According to relativity theory applies $M_B = M_o * 1 / \sqrt{1 - (v / c_o)^2} = M_o * \gamma$

with v = velocity of the object observed from the perspective of a stationary observer

M_B = mass of a substance moving with the velocity v from the perspective of an observer at rest (movement mass)

M_o = mass of a substance at rest from the perspective of a observer at rest (rest mass)

$\gamma = 1 / \sqrt{1 - (v / c_o)^2}$ = relativity factor

When the observed object is a photon with the movement mass m, according to relativity theory applies

$$m = m_o * \gamma \quad \text{or} \quad m_o = m * 1 / \gamma$$

with m = movement mass of a photon

m_o = rest mass of a photon

Since the speed of the photon from the perspective of the observer at rest is always constant c_o, it is

$$m_o = m * 1 / \sqrt{1 - (c_o / c_o)^2} = m * 0 = 0$$

In accordance to relativity theory the rest mass m_o of a photon is always zero.

Conversely the movement mass of a photon can be indicated as $m = m_o * \gamma$, but when it moves relatively to the observer with the speed of light c_o, the actual value can not be determined in this way, because it is

$$m = m_o * \gamma = 0 * \infty$$

In order to determine the movement mass of a photon, we set up a relationship between mass and energy, and it is

force = mass x acceleration $\quad F = m * dv / dt$

energy = force x distance $\quad E = \int F * ds$

From these two equations we obtain the relation

$$E = \int m * (ds/ dt) * dv = \int m * v * dv$$

For a photon with constant velocity c_o follows

$$E = \int m * c_o * dv = m * c_o \int dv = m * c_o (c_o - 0) = m * c_o^2$$

With this result and from the well-known equation of quantum theory for the energy of a photon emitted from a light source at rest relative to the observer

$$E = h * f_o$$

with $\quad$ h = Planck constant

f_o = frequency of the electromagnetic ‘wave’ emitted from the light source

we obtain for the movement mass of a photon

$$m = h * f_o / c_o^2$$

This makes it possible to indicate the values of movement mass, momentum and energy of a photon emitted from a light source at rest relative to the observer according to relativity theory summarized as follows, and because c_o and h are constants, it applies

$$m = h * f_o / c_o^2 \sim f_o$$

$$p = m * c_o = h * f_o / c_o \sim f_o$$

$$E = m * c_o^2 = h * f_o \sim f_o$$

It should be noted that from the perspective of the observer movement mass, momentum and energy of a photon are determined by the Doppler frequency of the received light, when the light source is moving relatively to the observer.

As derived in Section 3.1 the relativistic Doppler frequency for a constant movement of the light source in axial direction of the propagation of light and towards the observer at rest is

$$f_B = f_o * (1 + v / c_o) * \gamma$$

So you get for movement mass, momentum and energy of a photon from the perspective of the observer the relations

$$m_B = h * f_B / c_o^2 \sim f_B$$

$$p_B = m_B * c_o = h * f_B / c_o \sim f_B$$

$$E_B = m_B * c_o^2 = h * f_B \sim f_B$$

4.2 Mass, momentum and energy of a photon according to the theory of objectivity

According to the theory of spatial and temporal objectivity of all movements within the stationary spatial reference frame the vacuum speed of light depends on the movement of the transmitter (light source) relative to this reference frame, as described in Section 2.3. If the light source is at rest ($v = 0$), or if we determine mass, momentum and energy of a photon relative to the transmitter ($c = c_o$), as in the theory of relativity it will be

$$m = h * f_o / c_o^2 \sim f_o$$

$$p = m * c_o = h * f_o / c_o \sim f_o$$

$$E = m * c_o^2 = h * f_o \sim f_o$$

In the moving direction of a transmitter with the speed v the velocity of a photon relative to the stationary reference frame however is

$$c = c_o + v$$

For determination of the mass or the mass equivalence of a photon we return to the energy equation

$$E = \int m * (ds/ dt) * dv$$

For the special case with $c = c_o + v_c$ = constant follows

$$E = \int m (c_o + v_c) dv = m (c_o + v_c) \int dv = m (c_o + v_c) (c_o + v_c - v_c) = m (c_o^2 + c_o v_c)$$

$$E = m * c_o^2 + m * c_o v_c$$

Let´s put this result in relation to the energy equation of electromagnetic radiation, so we get

$$E = m * c_o^2 + m * c_o v_c = h * f_R$$

with f_R = observed frequency of the light relative to the stationary reference frame ('receive frequency' of the stationary receiver)

For propagation of light in direction of the transmitter (see 2.3 C) in accordance with the theory of objectivity

$$f_R = f_o (1 + v_c / c_o)$$

When we replace h in the above energy equation by $m * c_o^2 / f_o$ and f_R by $f_o (1 + v_c / c_o)$, we see that the two separately identified values of the photon energy from a moving transmitter (light source) match

$$E = h * f_R = (m * c_o^2 / f_o) * f_o (1 + v_c / c_o) = m * c_o^2 + m * c_o v_c$$

This makes it possible to indicate the values of mass, momentum and energy of a photon according to the objectivity theory summarized as follows

$$m = h * f_R / (c_o^2 + c_o v_c) = h * f_o / c_o^2 \sim f_o$$

$$p = m * c_o + m * v_c = h * f_R / c_o \sim f_R$$

$$E = m * c_o^2 + m * c_o v_c = h * f_R \sim f_R$$

Thus, differing from theory of relativity, the theory of objectivity doesn´t know the notion 'rest mass'. However, instead of this we can use for a substance at rest ($v = 0$) the notion 'rest energy'. It is identical with the potential radiation energy $E_o = m * c_o^2$ of the substance at rest.
According to the theory of objectivity the mass of a substance so is a measure of its 'rest energy' or of the potential radiation energy of the substance at rest.

Regarding the gravitational effect between substances, the question is whether the 'rest energy' of the substance (mass in the sense of the theory of objectivity) or their relative total energy ('rest energy' plus the additional energy supply through energy-related increase) is decisive.
Because of the 'mass'-increase observed in the sense of relativity theory for moving substances, the latter is to be taken into account in case of the theory of objectivity.

For the mass or the mass equivalence of a photon we obtain according to the theory of objectivity the same value as for its 'movement mass' relative to the light source in the theory of relativity. It is proportional to the radiation energy of a photon emitted from a stationary substance and equal to the mass defect, which this substance undergoes when the photon is emitted. In the case that the transmitter (light source) is at rest or relative to the moving transmitter ($f_R = f_o$ and $v = 0$) also momentum and energy of a photon are identical with the values referred to relativity theory.

In the equations of momentum and energy

$$p = m * c_o + m * v_c \quad \text{and}$$

$$E = m * c_o^2 + m * c_o v_c$$

we may very well see that the additional momentum and energy portions caused by the movement of the transmitter (light source) toward the rest frame are $\Delta p = m * v_c$ and $\Delta E = m * c_o v_c$ respectively; i.e.

$$p = p_o + \Delta p = h * f_o (1 + v_c / c_o) / c_o = h (f_o + \Delta f) / c_o$$

$$E = E_o + \Delta E = h * f_o (1 + v_c / c_o) = h (f_o + \Delta f)$$

with p_o = momentum of a photon emitted from a stationary transmitter
(or relative to a moving transmitter)

E_o = energy of a photon emitted from a stationary transmitter
(or relative to a moving transmitter)

For the stationary receiver (observer at rest relative to the objective reference frame) the increase of impulse Δp and the increase of energy ΔE appear as a Doppler effect, whereat the additional portions of momentum and energy are proportional to the value $\Delta f = f_o * v_c / c_o$ (increase of the frequency of light) and thus proportional to the speed of the transmitter.

Because for the increase of Doppler frequency theoretically no limits are put, the same is true for momentum and energy of a photon under the condition that the radiation source can reach faster-than-light speeds relative to the stationary receiver.

It applies $$\Delta p \sim \Delta E \sim \Delta f \sim v_c$$

From the perspective of the receiver is to be noticed that the ‘receive speed’ of light (phase speed of light $c_R = f_R * \lambda_R$) is always constant c_o (see Section 2.3 and 2.4) and thus an objective superluminal speed of the photon beam is not detectable by measuring only f_R and λ_R.
This means that from the relativistic view of the receiver also for the determination of energy and thus for the determination of the mass equivalence of a photon the constant light speed c_o must be taken as a basis for the speed of the photon beam.

With $$\Sigma E_R = n * m_R * c_R^2 = n * m_R * c_o^2 = n * h * f_R$$

as the total energy of the photon beam we obtain for the mass equivalence of a single photon from the perspective of the receiver the relation
$$m_R = h * f_R / c_o^2$$

Hence, bearing some resemblance to the theory of relativity, from the perspective of the receiver we have it here to do with a relativistic ‘mass’-increase.

Because $f_B = f_o * (1 + v / c_o) * \gamma$ referred to relativity theory

and $f_R = f_o * (1 + v / c_o)$ according to objectivity theory,

however, in our case it is by the relativity factor γ less.

After the aforesaid it is understandable that the deflection of light in a gravitational field and the observed ‘mass’-increase of accelerated particles are no conclusive proofs of the correctness of the theory of relativity, as according to the theory of objectivity also light has mass equivalence and the relativistic ‘mass’-increase of moving particles also can be explained, objectively speaking, by that the whole of relative energy of the particles is decisive for their gravitational effects.

5. Summary

As shown in the beginning in Section 1, the physical results of observation depend on the reference frame of the observer. Since from the perspective of the observer different reference frames can be chosen, the question arises as in what reference frame the physical observations are most likely in line with the natural laws, which are independent of the reference frame of the observer.
For the observation of light it applies that the observational results match the best with the known physical laws, when the light source itself is chosen as a reference point for the rest frame ($c = c_o$). But, based on a non-relativistic view of space and time, not all transmitters (light sources) in motion relative to each other can at the same time be chosen as equal reference points of a reference frame with regard to the speed of light. In the theory of relativity this is possible, because the speed of light is understood as independent of the reference frame, and thus space and time are to be regarded as relativistic, i.e. dependent on the relative velocity between the light source and the observer.
This leads not only in terms of physical sizes of space and time, but also in terms of the mass of a substance to relativistic sizes, which depend on the relative movements of the observer.
That in our case selected preferred reference frame, however, permits that space and time and the mass of a substance (= potential radiation energy of a substance at rest) are maintained as physical sizes independent of the point of observation. Regarding the gravitational interaction between substances moving relatively to each other, however, we must as pointed out in Section 4.2, unlike in the classical physics, consider the whole of relative energy of the referred substances as effective sizes, i.e. according to the theory of objectivity light has a motion mass in dependence on the

relative movement and influence is given by gravitational fields. *Thus also the deflection of light in a gravitational field is not a proof of the correctness of the theory of relativity.*

In our preferred, as objective regarded reference frame the vacuum speed of light, the momentum and the energy of a photon emitted from a transmitter depend on the movement of the transmitter relative to the inertial rest frame and only in the case of a stationary transmitter or relative to the moving transmitter as the point of reference they are identical with the values according to the relativity theory.
The ‘receive speed’ of light (the phase speed of light observable in the axial direction of propagation of light) is also under the assumption of an objective reference frame always constant c_o, regardless of the movements of the transmitter and receiver.
Crucial to the question of which theory correctly describes the physical reality is the experimental investigation, whether the light speed of a field point of the radiated electromagnetic quanta field, in other words the absolute speed of light, is always constant c_o independent of its frame as postulated in the theory of relativity, or whether the speed of the transmitter relative to the preferred reference frame at rest must be taken into account in accordance with the theory of objectivity. For such a proof the Michelson-Morley experiment, or any other measurement of the light speed of a light wave or of a particle flow of light relative to the light source ‘at rest or in motion’ or relative to the observer ‘at rest or in motion’ is not sufficient.
However, one way of review is the detailed examination of Doppler effect, whereby not only the frequency of a radiated electromagnetic ‘wave’ or of a flow of particles, but also the wavelength or the distance of particles at both the transmitter and the receiver and independent of those the relative speed between transmitter and receiver have to be determined under vacuum conditions.
As shown in Section 3.1 and 3.2 the ‘receive frequency’ and the ‘receive wavelength’ differ by the relativity factor γ in the two theories. The transversal Doppler effect as expected according to the relativity theory may also not occur in conformity with the theory of objectivity.
Thus the experimental proof that a transversal Doppler effect doesn´t exist, would be a sufficient proof against the theory of special relativity.
A positive proof of the correctness of the theory of objectivity would be the evidence that in the case of a relative axial movement between transmitter and receiver the condition

$$f_R = f_o * (1 \pm v / c_o) \qquad \text{and}$$

$$\lambda_R = \lambda_o / (1 \pm v / c_o)$$

for the experimental determination of Doppler frequency and Doppler wavelength is fulfilled and the relativity factor γ doesn´t occur.

Appendix:

Reflections on the anisotropy experiments of G.F. Smoot et al.

The generally accepted theory says that the *cosmic microwave background* (CMB) is the result of a 'Big Bang', by which approximately 13.7 billion years ago our present universe began and that the scattering of photons off matter particles, that we measure as CMB and that obviously fills the entire universe, comes from a spherical surface, called the *surface of last scattering.* This radiation originated roughly 380,000 years after the 'Big Bang' reaches our planet today. By the extension of space also the CMB undergoes a redshift. The redshift of the background radiation is indicated as z = 1089 ± 0.1%. Radiation, which comes from regions of higher density, in addition undergoes a gravitational redshift (Sachs-Wolfe effect), so that the background radiation in the appropriate directions has an only slightly lower temperature. These slight fluctuations in temperature in smaller areas (about 0,001%) have been observed by the satellites COBE in 1993 and WMAP in 2003, but do not change the fact that the CMB is almost homogeneous and isotropic and shows only minor deviations.[1]

Also the observation of the CMB anisotropy in the experiment by G.F. Smoot of the year 1977 has been repeatedly confirmed by satellite observations (COBE 1991 and WMAP 2003).
The observed dipole-like anisotropy of CMB in direction and in the opposite direction of the constellation LEO is unanimously interpreted as motion of the Earth (our solar system) relative to the CMB in direction of LEO.
The measurements by COBE in 1991 revealed a velocity of Earth relative to the CMB of v = 371 ± 0.5 km / sec, the measurements by WMAP in 2003 of v = 368 ± 0.2 km / sec (measurement by G.F. Smoot in 1977: v = 390 ± 60 km / sec).[2]

For both, the classical as well as the relativistic Doppler effect, the ratio of observed blue and red shifted Doppler frequencies is

$$f_b / f_r = (1 + v/c_o) / (1 - v/c_o) \quad (1)$$

and for the Doppler wavelengths applies

$$\lambda_b / \lambda_r = (1 - v/c_o) / (1 + v/c_o) \quad (2)$$

Thus in both cases the ‚receive speed' of light in axial direction of the anisotropy of light is

$$c_R = f_b * \lambda_b = f_r * \lambda_r = c_o\,.$$

The Special Relativity Theory (SRT) is not refutable on this way, because according to the relativity theory all inertial systems are equally entitled, i.e. the cosmic microwave background is not a preferred reference frame and the Doppler effect is not caused by change of the speed of light, but by the change of time and space referred to the relative motion between the reference frame 'light source' and the reference frame of the observer.

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[1] http://de.wikipedia.org/wiki/Hintergrundstrahlung
[2] C.E. Navia, C.R.A. Augusto, D.F. Franceschine, M.B. Robba und K.H. Tsui, Search for anisotropic light propagation as function of laser beam alignment relative to the Earth´s velocity vector, February 5, 2008

However, if we put the blue- and redshifted CMB measured in direction and in opposite direction of the LEO constellation in relation to the CMB observable in 90° angle to it, the situation will be different.
According to relativity theory there should be a transversal Doppler effect, while according to a non-relativistic theory the transversal 'receive frequency' is equal to the emitted frequency f_o. So it applies

a) for the non-relativistic Doppler effect (f_d = observable Doppler frequency in the direction or opposite direction of the LEO constellation and f_t = observable frequency of the CMB perpendicular to that)

$$f_d / f_t = (1 \pm v/c_o) \qquad (3)$$

b) for the relativistic Doppler effect (f_d = observable Doppler frequency in the direction or opposite direction of the LEO constellation and f_t = observable frequency of the CMB perpendicular to that; γ = relativity factor)

$$f_d / f_t = (1 \pm v/c_o) * \gamma^2 \qquad (4)$$

Because f_d and f_t can be determined by measurements and v by f_b / f_r according to equation (1), all values in the equations (3) and (4) are known.
However, since equations (3) and (4) differ by the factor γ^2, only one of the two relations can be correct.

When we take the WMAP-based measurement of 2003 as a basis, we get

$$\gamma^2 = 1 / (1 - v^2/ c_o^2) = 1{,}000001507 \pm 2 * 10^{-9}$$

With $1 + v/c_o = 1,\ 0012275 \pm 7 * 10^{-7}$ the ratio of the blueshifted Doppler frequency in the direction of the LEO constellation to the CMB-frequency observable in 90° angle to it yields the following values:

a) for the non-relativistic Doppler effect

$f_b / f_t = (1 + v/c_o) = 1,\ 0012275 \pm 7 * 10^{-7}$

a) for the relativistic Doppler effect

$f_b / f_t = (1 + v/c_o) * \gamma^2 = (1,\ 0012275 \pm 7*10^{-7}) * 1{,}000001507 \pm 2 * 10^{-9} = 1{,}0012290 \pm 8 * 10^{-7}$

Since the deviations of the two values are within the range of measurement errors and also within the low temperature fluctuations (anisotropies) of the CMB, which are independent of the relative motion between Earth and CMB, the metrological proof, which of the two values and thus which of the two theories is correct or wrong, also in this way is not possible.

However, the fact that a dipole-like anisotropy of CMB is to be seen only in one axial direction is a clear indication that this is no objective anisotropy of CMB, but that the relative motion between the observer and the background radiation is the cause, i.e. the anisotropy observable in the direction of the LEO constellation is clearly a Doppler effect.

If in accordance with the initial remarks made on the formation of the largely isotropic cosmic background radiation we additionally assume that a reference frame at rest relative to this background radiation is a preferred and objective reference frame with its zero point naturally coinciding with the starting point of 'big bang', then also the movement of our planet in the direction of LEO constellation detected by G.F. Smoot may be regarded as an objective motion. Obviously it results from overlapping gravitational movements of the Earth, our solar system, the entire Milky Way, the galaxy clusters related and possibly also from a relative motion due to the continuing expansion of the entire universe.

Thus, differently from the relativity theory, the changes of frequency and wavelength (distance of photons) of CMB observed by G.F. Smoot et al. must not be interpreted as if the observer is at rest. In fact, from the perspective of a frame objectively at rest relative to the CMB, frequency and wavelength (distance of photons) of CMB do not change on the way to Earth; in other words, from an objective perspective also space and time are not transformed. From the perspective of such an objective rest frame the reason for the Doppler effect observed on Earth is solely the movement of Earth and the resulting change of impact velocity of the photon beam ('light-wave') at the observer. While the speed of photons, i.e. the speed of light c_o objectively does not change, in this case the impact velocity of the photons increases or decreases corresponding to the velocity of Earth v; i.e. $c = c_o \pm v$. As shown in Section 2.3, this leads to the result that the 'receive frequency' f_R and the distance of the photons received (the 'receive wavelength') λ_R changes as follows:

$$f_R = f_o * (1 \pm v / c_o) \qquad \text{and}$$

$$\lambda_R = \lambda_o / (1 \pm v / c_o)$$

The 'receive speed' of the photon beam ('light-wave') from the perspective of the observer on Earth is then always

$$c_R = f_R * \lambda_R = f_o * \lambda_o = c_o$$

When the observer is not objectively at rest, this 'receive speed' (phase speed of light) also must not be equated with the real velocity of the photons c relative to the observer (impact velocity).
If the speed of the photons relative to the observer would always be constant c_o, as the theory of relativity requires, objectively speaking, the Doppler effect should not occur on Earth, because frequency and photon distance (wavelength) of the CMB objectively do not change.

The discovery of the CMB and the outcome of the anisotropy experiments by G.F. Smoot et al. together with the theory about the formation of the largely isotropic CMB do not refute the SRT, but at least they give rise to doubts on it, because contrary to the theory of relativity obviously there exists a preferred reference frame, which allows an objective view of all cosmic movements.
The Doppler anisotropy of the CMB can be explained in this way without contradiction, while the theory of relativity in explaining the observed Doppler anisotropy from the perspective of a reference frame at rest relative to the CMB because of the postulate of the absolute speed of light leads to contradictions.