A presently overlooked explanation for the constant speed of light, relativistic effects and magnetic force

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Abstract. This study discusses a new, unusual but simple explanation for the constant speed of light, some relativistic effects and magnetic force. The starting point of the discussion is a single, plausible postulate which links the principle of relativity with a constant speed of light for all inertial observers without space and time assumptions. The postulate makes it possible to further explain the effect of time dilation, relativistic Doppler effect and Lorentz force. This study also shows that the concept leads almost, but not exactly to the special theory of relativity. It is surprising that this approach has not been discussed to date. Because of its high interpretive power, the conclusion is that the hypothesis remains completely unexplored.

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Contents

1. Introduction

1.1. The idea

The special theory of relativity (STR) binds together two seemingly contradictory notions by using the Lorentz transformation:

- the universal constancy of the speed of light and
- special principle of relativity.

However, the Lorentz transformation is not the only and simplest way to link these notions together logically and consistently. It is remarkable that the basic idea discussed here remains completely unexplored. The motivation for this study is to show the potential of this approach and that it warrants further investigation.

The basics can be described as follows: Let us assume that light has many different, arbitrarily set velocities from zero up to very large values far beyond c. What will happen if the matter only interacts with that component of light which has the exact speed of c in the rest frame of the matter? It will appear as if the speed of light is constant, i.e. independent of the velocity of the sender or receiver. Furthermore, the special principle of relativity is valid, which means that an observer would not be able to determine if he is resting or moving.

Stated as a postulate the assumption is as follows:

Postulate 1 *Light has no special velocity. However, matter can only interact with that part of light which has the light absorption speed c in the rest frame of the matter.*

The difference between the STR or ether theory is that the constancy of the light speed is because of this assumption not longer a property of the transmission medium, but instead a characteristic of the receiver. The study demonstrates that this postulate has a very high degree of interpretive power.

1.2. Organization of the study

Postulate 1 and the resulting velocity-selective light absorption (VSLA) theory are within the STR domain and field of electrodynamics. Both are discussed in this study in two relatively independent sections. The impact to other disciplines is not considered.

2. STR domain

This section deals with whether the most important experimentally proved results of the STR could be explained using the VSLA theory. It turns out that this is indeed the case. However, in this section, it will become clear that some effects are the result of the interpretation of the data using the STR. In other words, it can be shown that a world which works according to the VSLA would generate data that could be explained using the STR.

2.1. Virtual trajectory of a moving object

In contrast to the STR, in the VLSA exists an absolute space, in which the origin of the reference frame can be chosen freely. This means that every object has a "true" space and time coordinate. However, it is not possible to observe this directly, because light has a transit time. In this study, it is shown how it is possible, on the basis of section 1.1, to infer the "true" trajectory of an object from its observed motion.

For this purpose, we assume an object that moves at a constant speed. Let $\hat{r}(\hat{t}) = \hat{v}\,\hat{t} + \hat{x}$ be the object's true equation of motion for an observer which rests at the origin of the coordinate system‡, with true velocity $\hat{v}$, true position $\hat{x}$ at time point $\hat{t} = 0$ and absolute time $\hat{t}$. Furthermore, it is assumed that $\hat{v} \geq 0$.

What is the perspective of an observer who believes in the STR? To clarify this point we assume that the resting observer sends light pulses and waits for the reflections to return. Let $\hat{t}_{s,k}$ ($k = 1$ and 2) be two points of time for sending such "locating" pulses (Figure 1).

‡ The true coordinates are marked with a carat symbol.

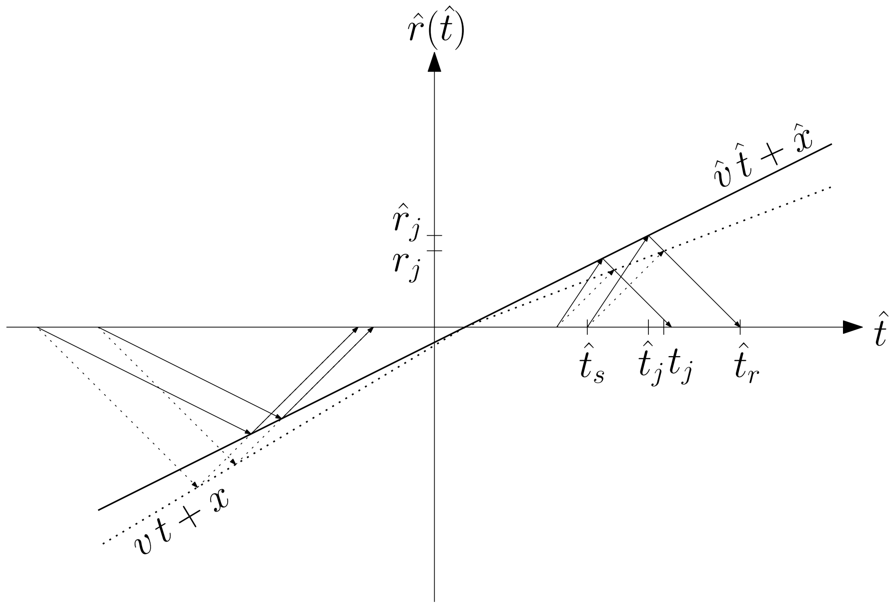

Figure 1. object locating with light pulses

According to the equation of motion, light has to bridge the distance $|\hat{r}(\hat{t}_{s,k})|$ when it is emitted. Postulate 1 states that the emitted light pulse contains components with different speeds. However, the receiver can only interact with the part which has the velocity $c+\hat{v}$ for objects moving away and $c-\hat{v}$ for approaching objects. From the receiver's viewpoint only these components have a velocity matching c. Furthermore, the condition $\hat{v} < c$ has to be valid for approaching objects without which no interaction is possible.

The position of the light front for an object moving away from the observer is given by $(c+\hat{v})(\hat{t}-\hat{t}_{s,k})$ and $-(c-\hat{v})(\hat{t}-\hat{t}_{s,k})$. By setting this equal to the equation of motion of the object, we obtain $\hat{v}\,\hat{t}_{j,k}+\hat{x} = (c+\hat{v})(\hat{t}_{j,k}-\hat{t}_{s,k})$ and $\hat{v}\,\hat{t}_{j,k}+\hat{x} = -(c-\hat{v})(\hat{t}_{j,k}-\hat{t}_{s,k})$. Using these equations, one can calculate the time required for the light pulse to reach the object. After rearranging the equations, we get

$$\hat{t}_{j,k} = \begin{cases} \left(1+\frac{\hat{v}}{c}\right)\hat{t}_{s,k}+\frac{\hat{x}}{c}, & \text{for objects moving away} \\ \left(1-\frac{\hat{v}}{c}\right)\hat{t}_{s,k}-\frac{\hat{x}}{c}, & \text{for approaching objects.} \end{cases} \tag{1}$$

The object "reflects" the light after "absorbing" it and then generates a new secondary light pulse which also consists of components with different speeds. Because of the postulate, the part with c is the only, which can be received in the rest frame.

At time $\hat{t}_{j,k}$, the secondary light pulse starts at the position $\hat{r}(\hat{t}_{j,k}) = \hat{v}\,\hat{t}_{j,k}+\hat{x}$. This means that it has to bridge the distance $|\hat{r}(\hat{t}_{j,k})|$ to reach the observer. Because the light pulse moves towards the observer, only the part of light with speed c is relevant. The secondary light pulse arrives at the observer at time

$$\hat{t}_{r,k} = \frac{1}{c}\,|\hat{r}(\hat{t}_{j,k})| + \hat{t}_{j,k} = \frac{1}{c}\begin{cases} (c+\hat{v})\,\hat{t}_{j,k} + \hat{x}, & \text{for objects moving away} \\ (c-\hat{v})\,\hat{t}_{j,k} - \hat{x}, & \text{for approaching objects.} \end{cases} \tag{2}$$

Substituting in equation (1), this becomes to

$$\hat{t}_{r,k} = \begin{cases} \frac{(c+\hat{v})^2}{c^2}\hat{t}_{s,k} + \frac{(2\,c+\hat{v})}{c^2}\hat{x}, & \text{for objects moving away} \\ \frac{(c-\hat{v})^2}{c^2}\hat{t}_{s,k} - \frac{(2\,c-\hat{v})}{c^2}\hat{x}, & \text{for approaching objects.} \end{cases} \tag{3}$$

In STR, light is thought to have the same speed c on the way to the target and back. An observer who is interpreting the data on the basis of this assumption will conclude that the reflection takes place not at time $\hat{t}_{j,k}$ but

$$t_{j,k} = \frac{1}{2}\left(\hat{t}_{r,k} - \hat{t}_{s,k}\right) + \hat{t}_{s,k} \tag{4}$$

at position

$$r_{j,k} = \begin{cases} +c\frac{1}{2}\left(\hat{t}_{r,k} - \hat{t}_{s,k}\right), & \text{for objects moving away} \\ -c\frac{1}{2}\left(\hat{t}_{r,k} - \hat{t}_{s,k}\right), & \text{for approaching objects.} \end{cases} \tag{5}$$

The virtual equation of motion $r(t) = v\,t + x$ for the object in the reference frame of the observer can be estimated with the space and time coordinates $(r_{j,k}, t_{j,k})$. For this, we state the equations

$$v\,t_{j,1} + x = r_{j,1} \quad \text{and} \quad v\,t_{j,2} + x = r_{j,2} \tag{6}$$

and solve them with respect to x and v:

$$v = \frac{r_{j,2} - r_{j,1}}{t_{j,2} - t_{j,1}} \quad \text{and} \quad x = \frac{r_{j,1}t_{j,2} - r_{j,2}t_{j,1}}{t_{j,2} - t_{j,1}}. \tag{7}$$

By using equations (4) and (5), we get

$$v = \alpha\,\hat{v} \quad \text{and} \quad x = \alpha\,\hat{x} \tag{8}$$

with

$$\alpha = \begin{cases} \frac{c\,(2\,c+\hat{v})}{c^2+(c+\hat{v})^2}, & \text{for objects moving away} \\ \frac{c\,(2\,c-\hat{v})}{c^2+(c-\hat{v})^2}, & \text{for approaching objects.} \end{cases} \tag{9}$$

Therefore, it is clear how a resting observer, who interprets the data using the STR, perceives an object which moves at a constant speed $\hat{v}$, when the world follows the mechanism described in section 1.1. In the rest frame, the trajectory

$$\hat{r}(\hat{t}) = \hat{v}\,\hat{t} + \hat{x} \tag{10}$$

becomes

$$r(t) = v\,t + x, \quad \text{with } v = \alpha\,\hat{v} \text{ and } x = \alpha\,\hat{x}. \tag{11}$$

This shows that a uniform motion is also uniform for the resting observer. However, it is an exception for large velocities; it seems that the speed suddenly slows down when the object passes the observer. Furthermore, it becomes clear that the observer does not perceive the true velocity. Instead the speed increases or decreases by a factor α. However, this effect is only for large velocities. For speeds $\hat{v} \ll c$, α is nearly one.

Another important finding is that an observer can never perceive speeds v greater than c. The limit $\hat{v}\,\alpha \to \infty$ is c for objects which are moving away. This means that an object moving faster than c would be perceived as slower than c. Approaching objects have to fulfil the condition $\hat{v} < c$ to interact with the observer. As a result, objects cannot be observed faster than light.

2.2. Time dilation

Section 2.1 shows that the velocity that an observer perceives depends on the interpretation. Here it is shown that the interpretation within the framework of the SRT leads to relativistic effects.

First, we prove that an observer has to conclude that the time between two events for a moving object is stretched by the factor

$$\gamma := \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}}. \tag{12}$$

The thought experiment in section 2.1 shows that when emitted light pulse reaches the object, the point of time $\hat{t}_{j,k}$ (Equation 1) is perceived by the observer as $t_{j,k}$ (Equation 4).

The ratio between the observed time difference $\Delta t_j := t_{j,2} - t_{j,1}$ and actual time difference $\Delta \hat{t}_j := \hat{t}_{j,2} - \hat{t}_{j,1}$ is

$$\frac{\Delta t_j}{\Delta \hat{t}_j} = \begin{cases} \frac{c^2+(c+\hat{v})^2}{c^2-\hat{v}^2+(c+\hat{v})^2}, & \text{for objects moving away} \\ \frac{c^2+(c-\hat{v})^2}{c^2-\hat{v}^2+(c-\hat{v})^2}, & \text{for approaching objects.} \end{cases} \tag{13}$$

Because the velocity $\hat{v}$ cannot be observed directly, the expression $v = \alpha(\hat{v})\,\hat{v}$ is rearranged to

$$\hat{v} = \begin{cases} c\left(\frac{\sqrt{c+v}}{\sqrt{c-v}} - 1\right), & \text{for objects moving away} \\ c\left(1 - \frac{\sqrt{c-v}}{\sqrt{c+v}}\right), & \text{for approaching objects.} \end{cases} \tag{14}$$

Substituting this in equation (13) gives the ratio between the perceived and the elapsed time as a function of v which is valid for objects moving away and approaching objects:

$$\frac{\Delta t_j}{\Delta \hat{t}_j} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \gamma. \tag{15}$$

This result corresponds to the STR. The time seems to slow down for the observer by the factor γ.

2.3. Relativistic Doppler effect (longitudinal)

Let us assume that an object with true velocity $\hat{v} > 0$ is at time $t = 0$ at the origin of the reference frame and it sends light pulses at a constant time interval $\hat{\tau}$. At time $k\,\hat{\tau}$ with $k \in \mathbb{Z}$ the object is at position $\hat{v}\,k\,\hat{\tau}$. The time required by the light pulse to travel to the origin of the frame is $|k|\frac{\hat{v}}{c}\hat{\tau}$ and the pulse arrives at time $k\,\hat{\tau} + \frac{\hat{v}}{c}|k|\,\hat{\tau}$. Hence the time delay for two pulses is

$$\tau = \left((k+1)\hat{\tau} + \frac{\hat{v}}{c}|k+1|\,\hat{\tau}\right) - \left(k\hat{\tau} + \frac{\hat{v}}{c}|k|\,\hat{\tau}\right). \tag{16}$$

This can be shortened for objects moving away ($k > 0$) to

$$\tau = \left(1 + \frac{\hat{v}}{c}\right)\hat{\tau} \tag{17}$$

and to

$$\tau = \left(1 - \frac{\hat{v}}{c}\right)\hat{\tau} \tag{18}$$

for approaching objects ($k < 0$). At least in both equations the true velocity $\hat{v}$ is replaced by using equation (14) with the perceived velocity v. We get

$$\frac{\tau}{\hat{\tau}} = \frac{\sqrt{c+v}}{\sqrt{c-v}} \tag{19}$$

for a source which is moving away and

$$\frac{\tau}{\hat{\tau}} = \frac{\sqrt{c-v}}{\sqrt{c+v}} \tag{20}$$

for an approaching source. This result also conforms the STR.

2.4. Relation with the Lorentz transformation

In a world which works according to the VSLA, the following observations can be made:

(i) **a constant speed of light:** Light has always the same velocity c, independent of the motion of the source or receiver.

(ii) **principle of relativity:** It is not possible to find a privileged frame because there is no reference frame which is different or special.

(iii) **symmetry:** If one observer perceives a second observer with a speed v, then the second observer determines the speed $-v$ for the first observer.

(iv) **time dilation:** An observer concludes that the time slows down for a moving object by the factor γ.

(v) **relativistic Doppler effect:** An observer confirms the relativistic Doppler effect in his experiments.

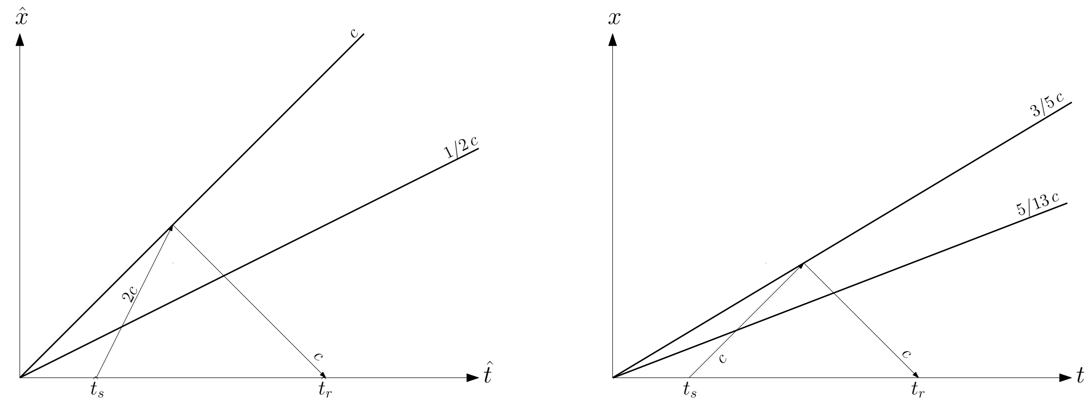

Figure 2. Object location with a light pulse: True coordinates (left), coordinates from the observers point of view (right). The figure is true to scale for $c = 1$.

The trial to join these points together with a single logical theory leads seemingly and almost inevitable to the Lorentz transformation.

The derivation of the Lorentz transformation is based on a configuration with two observers who are watching the same object. Figure 2 gives an example. The true configuration in the absolute space is shown on the left. The first observer rests and watches the second observer moving away. Furthermore, he observes the object with the true velocity c.

The resting observer sends out a light pulse at time $\hat{t}_s$. While moving towards the object, the pulse passes the moving observer before it is reflected. The secondary light pulse first reaches the moving observer and then reaches the resting observer at time $\hat{t}_r$.

Because of the facts described in section 2.1, the resting observer perceives the situation as shown on the right side of figure 2. From his viewpoint and according to equation (14) the object velocity is only $3/5\,c$. The second moving observer seems to be slower as well. The right side of figure 2 also shows that the light has the speed c in both directions.

Such configuration is the most commonly used starting point to derive the Lorentz transformation in the STR [1]. At first glance, the VSLA also enables the derivation of the Lorentz transformation. The arguments could be as follows:

On the basis of figure 3, it can be stated that the light pulse seems to arrive at the object at time

$$t_j = \frac{1}{2}\left(t_r - t_s\right) + t_s = \frac{1}{2}\left(t_r + t_s\right) \quad \text{at place} \quad x_j = c\frac{1}{2}\left(t_r - t_s\right) \tag{21}$$

from the viewpoint of the first observer. Furthermore, the first observer assumes that the second observer perceives the encounter of the light pulse and the object at time

$$t'_j = \frac{1}{2}\left(t'_r + t'_s\right) \quad \text{at place} \quad x'_j = c\frac{1}{2}\left(t'_r - t'_s\right). \tag{22}$$

A rearrangement of the equations (21) with respect to t_s and t_r leads to

$$t_s = t_j - \frac{1}{c}x_j \quad \text{and} \quad t_r = t_j + \frac{1}{c}x_j. \tag{23}$$

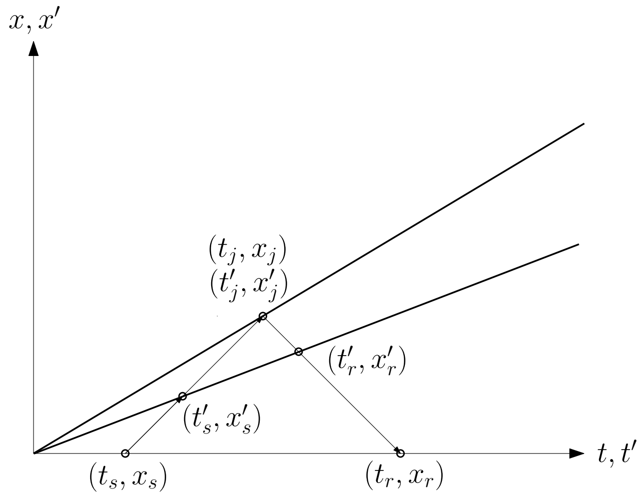

Figure 3. Configuration from the viewpoint of the first observer.

Similar to equation (22),

$$t'_s = t'_j - \frac{1}{c}x'_j \quad \text{and} \quad t'_r = t'_j + \frac{1}{c}x'_j. \tag{24}$$

Section 2.3 shows that a light pulse sent out at time t arrives at the receiver at time $\sqrt{c+v}/\sqrt{c-v}\,t$, when the sender and receiver are moving away from each other and have had the same position at time $t = 0$. Figure 3 shows that the resting observer at time t_s sends a light pulse that the observer receives at time t'_s, which means

$$t'_s = \frac{\sqrt{c+v}}{\sqrt{c-v}} t_s. \tag{25}$$

Furthermore, we can observe that the moving observer seems to send out a light pulse at time t'_r. This pulse reaches the resting observer at time

$$t_r = \frac{\sqrt{c+v}}{\sqrt{c-v}} t'_r. \tag{26}$$

Substituting equations (23) and (24) in equations (25) and (26) results in the Lorentz transformation after rearrangement

$$t'_j = \gamma\, t_j - \gamma \frac{v}{c^2}\, x_j \tag{27}$$

$$x'_j = \gamma\, x_j - \gamma\, v\, t_j. \tag{28}$$

It was already pointed out that in the VSLA the Lorentz transformation is *false*, because in the derivation a hidden aussumption has to be fulfilled which is not valid for the VSLA. The error is the notion that the observer perceives the light pulse when it is passing him on the way to the object. In the STR, this is secretly presupposed and leads to the necessity to give up the Euclidean space. However, in the VSLA, the concept that every inertial reference frame would interact with the same part of a light pulse has to be discarded. Nonetheless, both ensure that the items i to v are finally fulfilled.

2.5. Twin paradox

Section 2.4 has demonstrated that the Lorentz transformation is not correct for the case of VSLA. However, there are additional mismatches in the predictions of the two models. For example, the twin paradox does not occur in the VSLA.

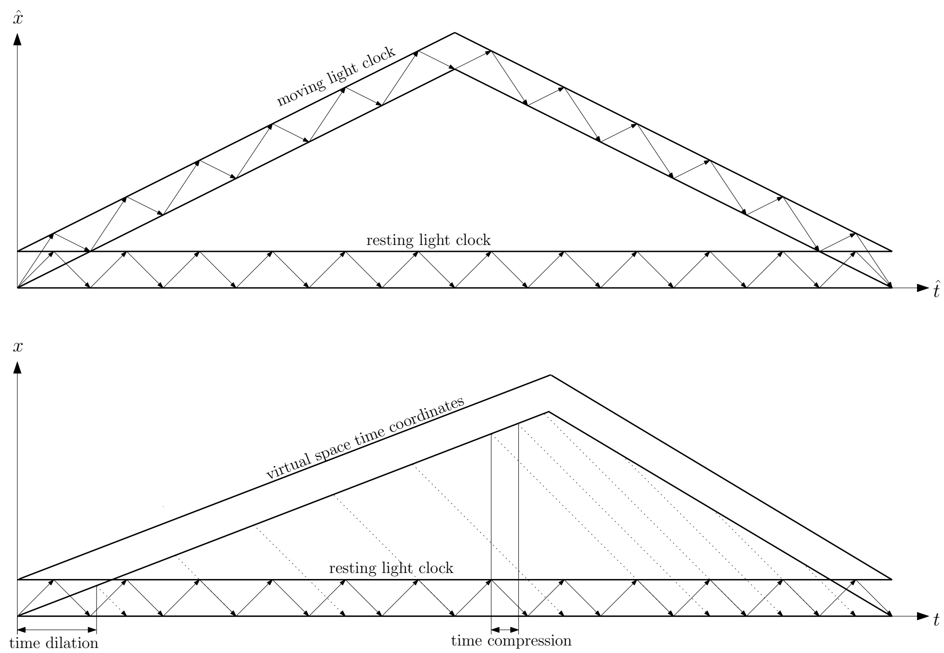

Figure 4. A moving and a resting light clock.

The upper graphics in figure 4 shows a light clock that moves away with half the light absorption speed from an observer with a second light clock. A light clock in this context is a hypothetical device consisting of two fixed opposite mirrors and between them a light pulse that is reflected back and forth without any dissipation. A tick of the clock takes place when the light pulse reaches the lower mirror. It can be seen that the moving light clock changes the direction of motion after six ticks and comes back with the same velocity. It is easy to count that the elapsed number of ticks for both clocks is exactly 12. Therefore, it seems that the twin paradox does not exist in the VLSA.

The second, lower graphic in figure 4 clearly shows why it does not come to a permanent time difference. The reason is that the situation looks asymmetric from the viewpoint of the resting observer. The true velocities $\hat{v}_1 = c/2$ and $\hat{v}_2 = -c/2$ have to be transformed with equation (14) to the observed velocities $v_1 = 5/13\,c$ and $v_2 = 3/5\,c$. This means that for the observer the light clock needs more time moving away than going back. It can be noted that the time dilation is $\gamma = 13/12$ for the first six ticks. This exactly corresponds with the expectations given by the STR. After the sixth tick, something unexpected happens, because the time goes much faster for two ticks. Subsequently, the behaviour becomes normal again and the expected time dilation occurs with a γ factor of 5/4. In sum, both effects compensate each other.

Because this asymmetry is not contained in the Lorentz transformation, inevitably the STR concludes that the moving light clock slows down. This finally leads to an inconsistency, which has to be cleared by using accelerations.

Weather the time dilation is a real or virtual effect has to be decided by experiments. The result of the Hafele–Keating experiment is an evidence for the STR. The simplicity and consistency of the argumentation speaks for the VLSA.

2.6. Relativity of simultaneity

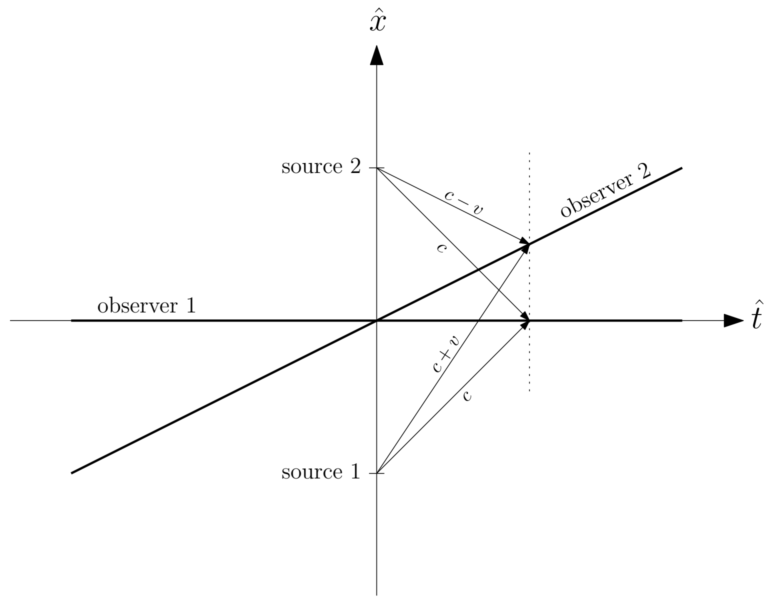

Figure 5. Simultaneously observed events are always simultaneous for every other inertial observer.

In the STR, the simultaneity of the events depends of the state of motion. Two light pulses, which come from opposite directions might arrive at an observer simultaneously but others may not. This is not correct in the VSLA. Figure 5 graphically shows that events which happen at the same time are also observed simultaneously by every observer. Here, the VSLA is also completely independent of the observers' relative motion. However, it should be noted that every observer, when interpreting the data using the STR, asserts that the other observer cannot have observed the same event simultaneously.

2.7. Superluminal matter

Another apparent difference to the STR is that in this model a strict ban for superluminal velocities does not exist. Only the speed for the transfer of information with light is limited to c. A physical object could however have in principle any arbitrary velocity.

Nevertheless, it is difficult to verify such fast objects because no superluminal motion can be observed with light.

2.8. Velocity-addition formula

In the STR, the velocity-addition formula can be derived from the Lorentz transformation. For that purpose, the differential forms of both equations are divided by each other:

$$v_o' = \frac{\mathrm{d}x_j'}{\mathrm{d}t_j'} = \frac{\gamma\,\mathrm{d}x_j - \gamma\,v\,\mathrm{d}t_j}{\gamma\,\mathrm{d}t_j - \gamma\frac{v}{c^2}\,\mathrm{d}x_j} = \frac{\frac{\mathrm{d}x_j}{\mathrm{d}t_j} - v}{1 - \frac{v}{c^2}\frac{\mathrm{d}x_j}{\mathrm{d}t_j}} = \frac{v_o - v}{1 - \frac{1}{c^2}\,v\,v_o}. \tag{29}$$

In this context, $v_o' := \mathrm{d}x_j'/\mathrm{d}t_j'$ is the velocity of an object for an observer who moves with respect to another observer with speed v. However, the velocity $v_o := \mathrm{d}x_j/\mathrm{d}t_j$ is the speed of the object for the resting observer.

In the example of figure 2, the resting observer may think that the moving observer perceives the speed of the object as $7/25\,c$. Conversely, the object has a true velocity c and the moving observer has a true velocity $1/2\,c$. This means that the moving observer should perceive the object with the same speed as the resting observer, namely $5/13\,c$.

This obvious contradiction results from the fact that the Lorentz transformation is not correct for the VSLA, because its derivation requires the assumption that the light pulse sent by the resting observer is perceived from the moving observer when it is passing him on the way to the object. However, the postulate argues that only light which has exact the speed of c in the rest frame of the observer can interact. From the observer's viewpoint, this light is too fast. Instead, he perceives slightly later a somewhat slower light component.

Regardless of the above mentioned facts, in the VLSA is the speed which is measured in the reference frame of the moving observer not just the speed difference between the object and moving observer. Instead, for the moving observer, the object's true velocity $\hat{v}_o'$ is

$$\hat{v}_o' = \hat{v}_o - \hat{v} = c\left(\frac{\sqrt{c+v_o}}{\sqrt{c-v_o}} - 1\right) - c\left(\frac{\sqrt{c+v}}{\sqrt{c-v)}} - 1\right) \tag{30}$$

when the observer and object move apart. In this context, v und v_o are the velocities of the moving observer and object seen from the resting observer, respectively. Because $\hat{v}_o'$ is the true velocity it has to be transformed with equation (9) in the perceived velocity v_o'. Finally, it follows the velocity-addition formula

$$v_o' = c\frac{\left(1 - \frac{\sqrt{c+v}}{\sqrt{c-v}} + \frac{\sqrt{c+v_o}}{\sqrt{c-v_o}}\right)^2 - 1}{\left(1 - \frac{\sqrt{c+v}}{\sqrt{c-v}} + \frac{\sqrt{c+v_o}}{\sqrt{c-v_o}}\right)^2 + 1}, \tag{31}$$

which differs from the formula in the STR, but it is also non-linear.

2.9. Some preliminary conclusions

So far we have learned that a world that follows the principles of VSLA can be explained with relative success by using the STR, because both basic demands of the VSLA – namely the universal constancy of the speed of light and principle of relativity – are tied together with the Lorentz transformation in a mathematical manner. The fact that the Lorentz transformation is not entirely correct for the VSLA is not so important because it is valid for the VSLA in relative terms. Thus, it is conceivable that the VSLA rather than STR is correct. In any case, it seems promising to analyze existing experimental results from the perspective of the VSLA.

3. VSLA and electromagnetism

It is well known that magnetic forces are caused by moving electric charges. The relations are described mathematically by the Maxwell's equations. However, these differential equations only describe and not explain. They connect electric and magnetic fields with moving electric charges, but do not explain the reasons behind these connections.

The STR shows that with the Lorentz transformation electric fields can be transformed in magnetic fields and vice versa. For this reason, the magnetic field is presently interpreted as an effect, which arises by the properties of the space-time continuum. However, there is no space-time continuum in the VSLA. This notwithstanding, magnetic force can be reduced in the VSLA to electric force in a very understandable manner.

3.1. Coulomb's law for uniformly moving point charges

In the following considerations, electrical point charges are considered as point-shaped objects that permanently emit and absorb "force particles". For simplicity, these "force particles" are named hereafter as "photons", even though they do not have any wave properties in this model. Furthermore, it is supposed that these photons have – according to postulate 1 – uniformly distributed velocities and directions of motion. A photon can only be absorbed when it has exactly a light absorption speed c with respect to the rest frame of the absorbing charge. Absorption causes a change in speed at the target in or against the direction of motion of photons, depending on the signs of the involved charges. The source does not change its state of motion when the photons are absorbed§

On this basis, an extended Coulomb's law is now postulated:

$$\mathbf{F}(\mathbf{x},\mathbf{v}) = \frac{q_s q}{4\,\pi\,\varepsilon_0}\,\frac{1}{\gamma^2}\,\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-(\mathbf{x}_s+\mathbf{v}_s\,\tau)\,\|^3} \tag{32}$$

with the side condition

$$\tau = \frac{\|(\mathbf{x}-\mathbf{v}\,\tau)-\mathbf{x}_s\|}{c} \tag{33}$$

§ Conservation of energy and momentum is ensured on average, because the source and destination emits and absorbs much "force particles", compensating random energy and momentum fluctuations.

and

$$\frac{1}{\gamma^2} = 1 - \frac{1}{c^2} \|\mathbf{v} - \mathbf{v}_s\|^2. \tag{34}$$

This formula can be used to calculate the total force $\mathbf{F}$, i.e. the electric and magnetic force, on a point charge with the charge q. The force not only depends on the position $\mathbf{x}$ but also on the velocity $\mathbf{v}$ of the destination. The source of the force is a uniformly moving point charge with velocity $\mathbf{v}_s$, and the charge q_s. $\mathbf{x}_s$ is the position where the absorbed photon was emitted. The time τ is the duration in which the photon exists as an independent physical object between emission and absorption.

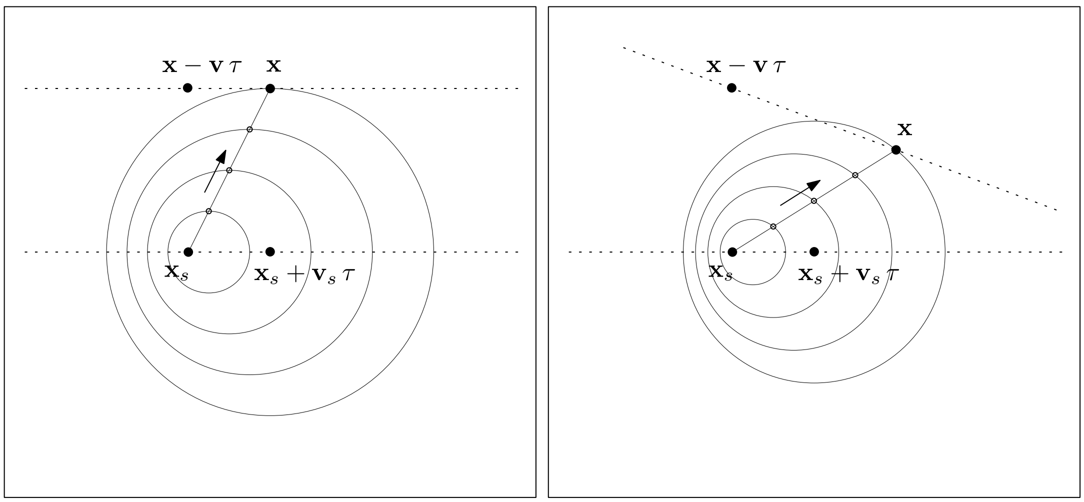

Figure 6. geometric interpretation

The modified Coulomb formula (32) can be interpreted geometrically in a very understandable manner. Both drawings in figure 6 show two different configurations, each comprising an emitting source point charge and an absorbing destination point charge. The left side of the figure illustrates a special case by which the relative position of the source and destination is unchanged over time; only the observer is moving. This case is discussed in section 3.4 in more detail. The right side of the figure shows the general case. The velocities of the source and destination have neither the same value nor the same direction.

Both drafts show the emission of a photon at position $\mathbf{x}_s$. The path of the photon, marked by small circles, runs from the source at position $\mathbf{x}_s$ at the time of emission to the destination at position $\mathbf{x}$ at the time of absorption. The large circles represent expanding light spheres and stand for many other photons that are emitted at the same time with the same speed but different direction of motion. Because the source point charges move with speed $\mathbf{v}_s$ the centres of these expanding light spheres also move with speed $\mathbf{v}_s$. This means that the centres of the light spheres always correspond to the positions of the point charges, if the accelerations can be neglected.

When the emitted photons arrive at the destination, its direction of motion does not point to the current centre of the light sphere but to the original place where the emission occured. This property is expressed by the term $\mathbf{x}-\mathbf{x}_s$ in equation (32) over the fraction bar. The radius of the light sphere corresponds, however, to $\|\mathbf{x}-(\mathbf{x}_s+\mathbf{v}_s\,\tau)\|$. Nevertheless, this does not completely explain the term under the fraction bar.

It could be assumed that an equation, which reproduces the drawings in figure (6), has to be proportional to the expression

$$\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|}\frac{1}{\|\mathbf{x}-(\mathbf{x}_s+\mathbf{v}_s\,\tau)\,\|^2}. \tag{35}$$

The first term is a unit vector which points in the direction of the force. The second term is inversely proportional to the surface of the light sphere at the time when the photon is absorbed and proportional to the surface density of the photon field and to the probability of the absorption of the photon. To show that the correct expression is given by equation (32), it is rearranged to

$$\mathbf{F}(\mathbf{x},\mathbf{v}) = \frac{q_s q}{4\,\pi\,\varepsilon_0}\,\frac{1}{\gamma^2}\,\eta\,\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|}\frac{1}{\|\mathbf{x}-(\mathbf{x}_s+\mathbf{v}_s\,\tau)\,\|^2} \tag{36}$$

with

$$\eta = \frac{\|\mathbf{x}-\mathbf{x}_s\|}{\|\mathbf{x}-(\mathbf{x}_s+\mathbf{v}_s\,\tau)\,\|} \tag{37}$$

It can be seen that the end part of equation (36) exactly corresponds to equation (35). The reason for the parameter η seems to be a type of Doppler effect, because η is greater one when the source and destination comes closer and lower otherwise.

The prefactor $1/\gamma^2$ cannot be explained without further assumptions. It can be stated that $1/\gamma^2$ only depends from the relative velocity but not from the direction and that charges with relative velocities near c can no longer interact electromagnetically with each other. Calculations have shown that it is necessary to obtain the correct direction of the Lorentz force. It can be assumed that the factor is associated to the relativistic mass.

However, equation (33) can be interpreted in a simple manner. It is a direct result of postulate 1 which says that only photons with velocity c can be absorbed with respect to the rest frame of the destination. Because $\mathbf{x}-\mathbf{v}\,\tau$ is the position of the destination at the time of emission and $\mathbf{x}_s$ is the position of the source at the time of emission, equation (33) denotes that the distance between the point charges is bridged by the photon always in the *same period of time* τ, independent of the speed of the source or destination.

3.2. Coulomb's law for electro and magnetostatics

To calculate with the modified Coulomb's law it is necessary to solve equation (33) for τ. As a result, there are two different solutions τ_1 and τ_2, which differs only by an algebraic sign:

$$\tau_{1/2} = \frac{\pm\sqrt{(c^2-\mathbf{v}\cdot\mathbf{v})\|\mathbf{x}-\mathbf{x}_s\|^2+(\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s))^2}-\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s)}{c^2-\mathbf{v}\cdot\mathbf{v}}. \tag{38}$$

In electro and magnetostatics all occurring velocities are much lower than the light absorption speed c. For this reason, it is useful and convenient to approximate equation (38) by using the first two terms of a Taylor series. Such approximation of equation (38) with respect to $\mathbf{v}$ at point $\mathbf{0}$ is

$$\tau_{1/2} \approx \check{\tau}_{1/2} = \pm\frac{1}{c}\|\mathbf{x}-\mathbf{x}_s\| - \frac{1}{c^2}\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s)\,. \tag{39}$$

It can be seen that only one solution, namely $\check{\tau}_1$, is greater than zero. This means that $\check{\tau}_2$ can be dropped. The only remaining formula for τ is

$$\check{\tau} = \frac{1}{c}\|\mathbf{x}-\mathbf{x}_s\| - \frac{1}{c^2}\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s)\,. \tag{40}$$

The caron symbol over τ marks that the formula can be only used in non-relativistic calculations.

Coulomb's law (32) also contains velocities $\mathbf{v}_s$ and $\mathbf{v}$. The resulting Taylor approximation is

$$\mathbf{F}(\mathbf{x},\mathbf{v}) \approx \frac{q_s q}{4\,\pi\,\varepsilon_0}\left(\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|^3} + (\mathbf{x}-\mathbf{x}_s)\left(\frac{2}{c^2}\,\frac{\mathbf{v}\cdot\mathbf{v}_s}{\|\mathbf{x}-\mathbf{x}_s\|^3} + 3\,\tau\,\frac{(\mathbf{x}-\mathbf{x}_s)\cdot\mathbf{v}_s}{\|\mathbf{x}-\mathbf{x}_s\|^5}\right)\right). \tag{41}$$

By substituting equation (40), it would follow an expression with which could be calculated. However, it would be necessary to take care of the integration over certain conductor configurations to include only such photons that arrive at the destination at the same time. To eliminate this inherent time dependency in equation (40), the zero-order term, which stands for the transit time of the light pulse, is omitted. The remaining term is substituted in equation (41). By using the relation $\mu_0 = 1/(c^2\varepsilon_0)$, it follows a non-relativistic Coulomb formula

$$\begin{aligned}\check{\mathbf{F}}(\mathbf{x},\mathbf{v}) &= \frac{q_s\,q}{4\,\pi\,\varepsilon_0}\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|^3}\\ &+\frac{q_s\,q\,\mu_0}{4\,\pi}\,\frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|^3}\left(2\,\mathbf{v}\cdot\mathbf{v}_s - \frac{3\,\mathbf{v}_s\cdot(\mathbf{x}-\mathbf{x}_s)\,\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s)}{\|\mathbf{x}-\mathbf{x}_s\|^2}\right),\end{aligned} \tag{42}$$

which describes both electro and magnetostatics. It can be seen that it contains the classical Coulomb's law and a term which represents the magnetic part. This part vanishes when one of the two velocities $\mathbf{v}_s$ or $\mathbf{v}$ is zero.

3.3. Magnetic force due to a current-carrying wire

This section proves that the modified Coulomb's law (42) gives the correct results for the standard model, namely an infinitely long, straight current-carrying wire. The model parameters are explained in figure (7) showing a current-carrying wire which is located on the x-axis without limitation of the generality and a point charge q that moves with velocity $\mathbf{v} = (v_x, v_y, v_z)^T$. When the point charge is considered, it is located at position $\mathbf{x} = (0, 0, a)^T$. Consequently, the distance to the wire is a. The current through the wire is modelled by electrons which are moving along the wire with speed $\mathbf{v}_- = (v_-, 0, 0)^T$. The electrical charge of the electrons is compensated in the rest frame with ions that

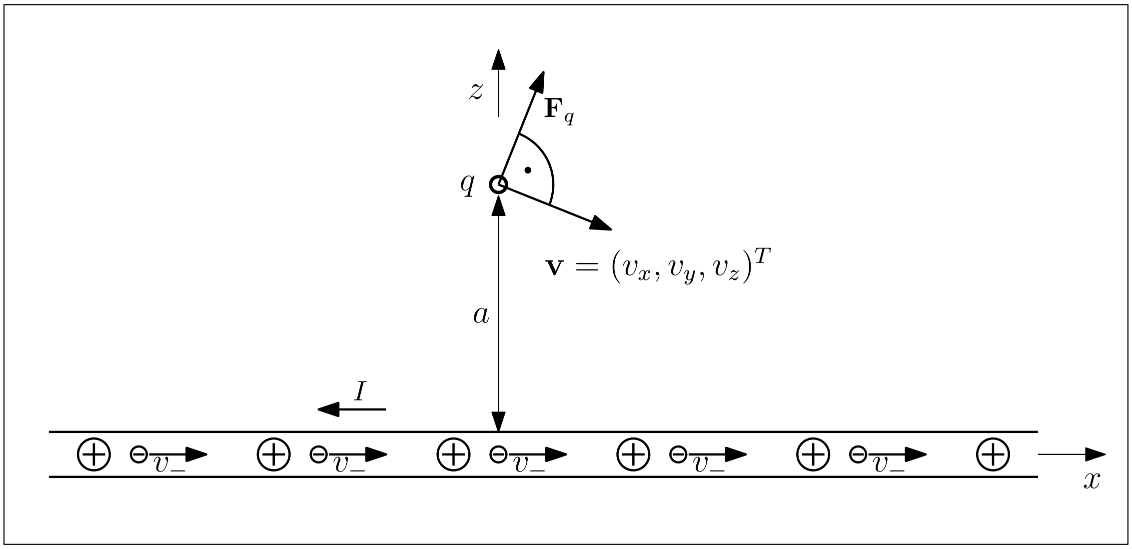

Figure 7. The configuration

do not move and therefore are of speed $\mathbf{v}_+ = (0,0,0)^T$. The y-axis is not shown in the figure.

By means of the Coulomb's law (42), the resulting magnetic force from the current to the point charge q can be calculated by overall integrating the single forces generated by the electrons and ions. The resulting total force $\mathbf{F}_q$ from the current-carrying wire to the point charge q is

$$\mathbf{F}_q = -\frac{q\,e\,\mu_0}{4\,\pi} \int\limits_{-\infty}^{+\infty} \frac{\mathbf{x}-\mathbf{x}_s}{\|\mathbf{x}-\mathbf{x}_s\|^3} \left(2\,\mathbf{v}\cdot\mathbf{v}_s - \frac{3\,\mathbf{v}_s\cdot(\mathbf{x}-\mathbf{x}_s)\,\mathbf{v}\cdot(\mathbf{x}-\mathbf{x}_s)}{\|\mathbf{x}-\mathbf{x}_s\|^2} \right) \mathrm{d}x \tag{43}$$

with $\mathbf{x}_s = (x,0,0)^T$, $\mathbf{v}_s = \mathbf{v}_- = (v_-,0,0)^T$ and the elementary charge e. The electrical part of equation (42) disappears because the electrons and ions neutralize each other. The integration yields

$$\mathbf{F}_q = \left(\frac{q\,e\,\mu_0\,v_z\,v_-}{2\,\pi\,a},\ 0,\ -\frac{q\,e\,\mu_0\,v_x\,v_-}{2\,\pi\,a} \right)^T . \tag{44}$$

Because electrical current is a flow of positive charge per unit of time, $-e\,v_-$ can be replaced with current I. The result is therefore:

$$\mathbf{F}_q = \left(-\frac{q\,\mu_0\,v_z\,I}{2\,\pi\,a},\ 0,\ \frac{q\,\mu_0\,v_x\,I}{2\,\pi\,a} \right)^T . \tag{45}$$

This result agrees precisely with that when using the Biot-Savart law in the Lorentz force formula $\mathbf{F}_q = q\,(\mathbf{v}\times\mathbf{B})$. Incidentally, the force from the point charge to the wire gives – as expected and demanded – the same result with reverse algebraic sign.

3.4. Electrodynamics and Galilean transformation

The considerations show that the Maxwell's equations and Galilean transformation must be contradictory. What is surprising is that the underlying effect is simple. It results from the fact that forces are realized by carrier particles. When emitted, such carrier particles, like photons, have a physical reality of their own. This means that they have also a trajectory and this has to be considered by a coordinate transformation.

The left part in figure 6 makes that quite clear. If the observer rests with respect to both charges, then he will only perceive the regular Coulomb force. Because of his motion, the path of the photon tilts away so that it finally gives rise to the magnetic force component. Consequently, the Galilean transformation is *basically not usable* for electromagnetic and gravitational force. Nevertheless, the Galilean transformation is a good approximation when the velocities are small and other effects do not compensate the main force, as in the case of the current-carrying wire. The considerations also show that the explanation of the magnetic force does not necessarily require the Lorentz transform. Perhaps a simple mechanism is hidden behind this effect.

4. Summary

The principle of VSLA has a surprising interpretive power. By using this simple concept, it is possible to effortlessly explain why we always measure speed c, regardless of the speed of the source or observer. Furthermore, it is feasible to show that the magnetic force can be derived with some simple geometric considerations from the regular Euclidean space by using the postulate 1.

Even though the VSLA is not fully equivalent to the STR, the theory gives the impression that it is partially true. That such a simple approach can easily explain certain different physical aspects can hardly be a coincidence. Unfortunately, it is very difficult to reconsider for the large number of existing experimental results that concern the STR directly or indirectly, if they can be also interpreted within the frame of the VSLA. Is it conceivable that systematic and interpretative mistakes were made in the measurement of the velocities of very fast objects? This is rather unlikely. Conversely, the idea that underlies the VSLA is until now completely discounted by all considerations and explanations. If the theory had been presented nearly at the same time as the STR, it would have surely led to an intensive and extensive discussion.

References

[1] Ray d'Inverno 1992 *Introducing Einstein's Relativity* (Oxford University Press, UK)