Understanding relativity

Hello, while seriously thinking about Einstein's relativity, I had the chance to access the fundamental article of 1905, the French translation of which I found on the website of the University of Quebec in Chicoutimi. He put me on the right track. A little later, I found an interesting hypothesis that uses Einstein's generalization of the relativity of Galileo's motion to celestial bodies in free fall in a gravitational field. The happiest idea of his life, he would have said. All celestial bodies, planets, stars, galaxies, and even galaxy clusters are in free fall.

The article "On the Electrodynamics of Bodies in Motion" of 1905 explains that the contraction of matter with velocity results from the fact that the measurements on a body in motion are not synchronized.

The "General Relativity" exhibited in 1915 is impressive. But it is incomplete. She explained that gravitational forces do not act instantaneously but move at the speed of electromagnetic waves, and the question of a medium capable of carrying these waves was once again raised. This led Einstein in 1920 to propose a new ether, the Lorentz ether, from which he removed immobility and made it react with matter. But he could not attribute to it a rational movement. He simply said "indeterminate movement".

In 1938, Einstein renounced this ether.

Too bad! I have found a possible explanation for this movement. Let's go back to Einstein's sentence who said in 1905 that light moves at the same speed V (we say c now) :p everything in the universe.

> *"Let us introduce another postulate, which at first glance is incompatible with the first, that light propagates in empty space at a speed V independent of the state of motion of the emitting body."*

Einstein explained that the speed of light does not depend on the speed of the body that produces it. He is right, it is a peculiarity of waves whose speed depends on the characteristics of their support, As he has suppressed the support of electromagnetic waves, his argument at first glance is open to criticism.

Our hypothesis: The ether exists. It is made up of corpuscles that have a very low mass and for the moment undetectable and other properties of which we know nothing. This mass, as small as it is, falls at the same speed as all massive bodies

The consequence, as incredible as it may be, is that the ether accompanies all the celestial bodies in their free fall and is even attracted to them, weakly but enough so that locally the ether is immobile.

The feat of this discovery, if it proves to be true, is that the constant speed of light in all the free-falling frames of reference of the universe is everywhere the same since in all these frames of reference locally the ether is stationary

Finding no physicists willing to discuss it, but nevertheless some encouragement, I am putting in open access the following article which I hope will interest some people likely to make this hypothesis known and get at least one experiment to be carried out to validate or invalidate it

Introduction

It turns out that Albert Einstein's relativity has not been well understood by everyone. The best proof is that we have kept the Lorentz transformations without apparently understanding that Einstein with a different approach disqualified the contraction of matter by replacing it with the fact that with velocity, the measurements we make in the direction of motion are made at different times. The time it takes for light to move from a given point to a more distant point that is moving away or closer varies and does not respect the timing of the measurements. The result is an apparent contraction that is not real.

For example, the paradox of the twins tells us that while the one who stayed on Earth sees the traveler with contracted lengths and a slowed flow of time, the traveler sees the same phenomenon on Earth. It is the relativity of motion that makes the observer always immobile and that it is the others who move in relation to him.

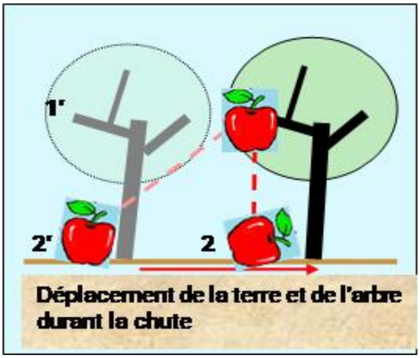
Einstein explained that the traveler had aged less because of the changes in reference frames. You have to understand the phases of acceleration to reach a high speed, then braking at the finish, from the U-turn and then again acceleration and braking on the way back

Note that on Earth gravity is 9.81 m/s^2. If the rocket accelerates to 4 m/s^2, the slower acceleration will make the traveler age faster!

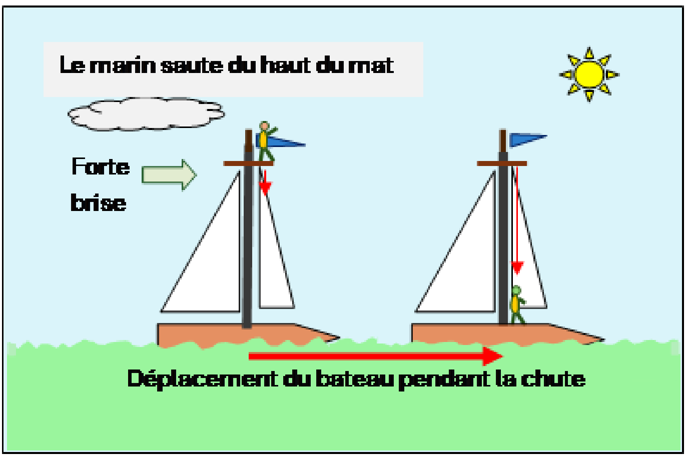
Forward

Galileo's relativity

Originally Aristotle demonstrated the immobility of the Earth by relying on the fact that if an object fell to the ground, if the Earth moved, during the fall it would move and the object would fall further from the point from which it started



Since then, we have known that this is false. It was Giordano Bruno who noticed that an object that fell from the top of the mast of a boat moving in a good breeze, fell at the foot of the mast instead of falling at the back of the boat.



Galileo took up the idea by avoiding quoting Giordan Brunon that the holy Catholic Church burned alive, but by describing what happens in the captain's cabin and which is the same whether the ship is moving forward or not. The speed acquired by objects carried along in a motion does not cease and remains the same as long as no force opposes it, so that during their fall the objects retain their initial speed and accompany the object that set them in motion. On a train or a plane, if you drop something, everything happens as if everything is still.

Galileo deduced that no matter how fast you are, if you don't see another frame of reference at a different speed you think you're standing still.

The conclusion is:

> *<< the movement at a constant speed in a straight line is always relative to an external frame of reference at a different speed that will be declared immobile by convention, or, you will declare yourself immobile by convection and it will be this that will move at the opposite speed. >>*

No misunderstanding, we are not immobile since others can see the movement of our frame of reference, but locally we can consider that we are, and vice versa for our observers. Some experiments such as the Foucault pendulum or the gyroscope make it possible to detect that we are in motion. We won't go into those aspects here, it's related to gravitation, which means that our free fall isn't actually a straight line.

The relativity of motion induces the notion of locality.

James Clerk Maxwell: Light is an electromagnetic wave

James Clerk Maxwell unifies the laws of electricity and magnetism and founds electromagnetism:
Maxwell's equations:

Gauss $\mathrm{div}\, E = \rho/\varepsilon_0$
Faraday $\mathrm{rot}\, E = - \partial B / \partial t$
Thomson $\mathrm{div}\, B = 0$
Ampère $\mathrm{rot}\, B = \mu_0\, j+\mu_0\, \varepsilon_0\, \partial E/\partial t$

He calculates the velocity of electromagnetic waves from the electrical permittivity and the magnetic permeability of the vacuum, ε_0 and μ_0:

$$c_0 = \frac{1}{\sqrt{\varepsilon_0 \cdot \mu_0}}$$

It finds 310,740 km/s. This is close to the speed of light calculated by astronomers, then measured on Earth by Fizeau and then Foucault. He established that light is indeed a wave, an electromagnetic wave.

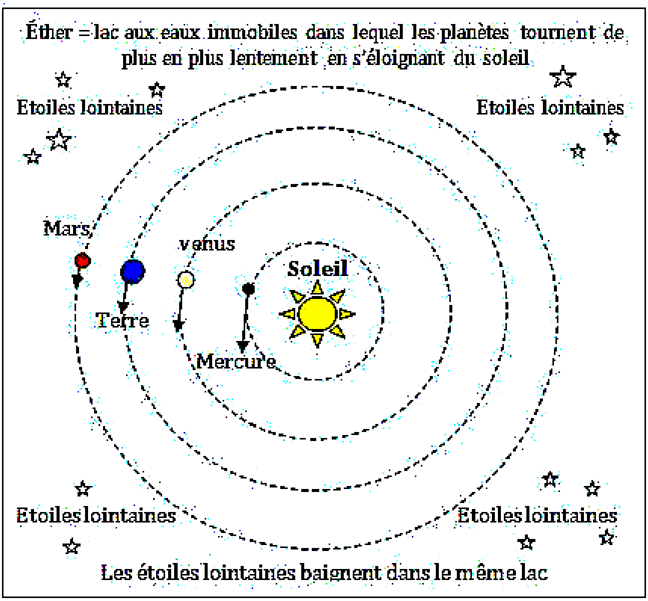
Note: the indices "0" correspond to what Maxwell calls the vacuum, we allow ourselves to assume that in an absolute vacuum these values would be zero and that therefore the speed of electromagnetic waves would tend towards infinity, insofar as they could propagate?

The 19th century ether

In the 19th century, waves were the undulations of water, a pure wave, the origin of their name. It was the sound that propagated through the air and certain materials. The waves were transmitted by a material medium that vibrated and transmitted its vibrations from one person to another. They decided to call this support "ether" It should be noted that Descartes himself had taken an interest in it and had imagined that it swirled and thus dragged the planets with it. We can smile about it, it could also be that we will have surprises if by some extraordinary means exists. Quantum mechanics seems to be very interested in this.

The aether was supposed to be in the frame of reference of the universe, motionless with the Sun and the fixed stars. This was the fatal mistake.

Vision de l'éther au 19è siècle



Michelson and Morley tried to demonstrate the motion of the Earth in relation to the ether without success.

Oliver Heaviside who reduced Maxwell's 20 equations to 4. calculates the deformations of the electric and magnetic fields in the vicinity of a moving charge, and what happens when it penetrates a denser medium, and the idea of the contraction of the spherical electrostatic field of an electron in

Ellipsoid of contraction: $\sqrt{1 - v^2/c^2}$

The idea that matter contracts with speed like the electric field of the electron does is gaining ground. George Frederick Charles Searle continued Heaviside's work.

In 1887, Woldemar Voigt published "On the Doppler Principle", in which he required the covariance of the homogeneous wave equation in inertial frames of reference (relativity) and assumed the invariance of the speed of light (Einstein's ^{2nd} postulate) and obtained results that were very close to the Lorentz transformations that would later notice.

The Lorentz-Poincaré transformations

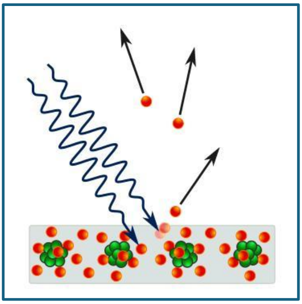
To compensate for the fact that the speed of the Earth is not additive with the speed of light, Lorentz considers matter to contract with speed as the electric field, which

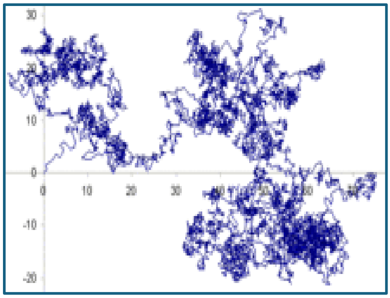
cancels the law of additivity of the velocities $\gamma = 1/\sqrt{1 - v^2/c^2}$

He later wrote: "It was these considerations published by me in 1904 that gave rise to Poincaré to write his Memoir on the Dynamics of the Electron, in which he attached my name to the transformation of which I have just spoken. [...] I have not indicated the most appropriate transformation. This was done by Poincaré and then by Messrs. Einstein and Minkowski. »

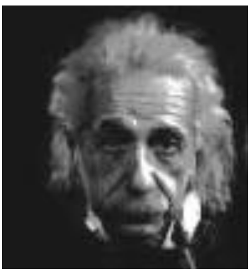
Einstein 1905 The Wonderful Year

In 1905 Einstein published four articles, all of them important, including "On the Electrodynamics of Bodies in Motion" later renamed "special relativity" A title in our opinion inappropriate since it talks about electromagnetism to which he applies Galileo's relativity without changing one iota.

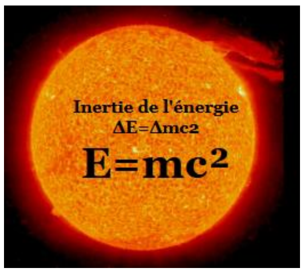




1) Photovoltaic effect, Brownian motion
Nobel Prize



3) Electrodynamics.
bodies in motion.



4) $E = mc^2$.

Three of the papers were well received and the one on the photoelectric effect used by our solar panels even earned him the Nobel Prize. The article "On the Electrodynamics of Bodies in Motion" provoked a lever of shields from most physicists of the time. The abandonment of the aether was inconceivable, and Einstein himself admitted that his postulates were questionable.

So it wasn't Einstein who was attacked but this article. That malicious people took advantage of it, of course. Those who claimed that he had copied Lorentz, on the other hand, were sorely mistaken. They revealed the difficulties in fully understanding this paper, which uses an entirely different phenomenon than that of the contraction of matter with velocity used by Lorentz. Einstein uses the fact that when measuring a moving object at v-speed, the extra time it takes for light to reach the farthest points that are moving away during that time, and back to detect the closest ones that are getting closer, results in skewed measurements. The result is similar to the supposed phenomenon of matter contracting with velocity. If we agree with Einstein, this contraction results from what he calls the desynchronization of clocks, the moment when the measurements are made depends on the distance separating the points in the direction of movement.

This is not easy to expose because they seem to be ignored. Probably those who have understood, like Einstein, have given up on explaining.

Relativity is and always will be Galileo. Einstein's contribution was to generalize the principle of relativity to objects in free fall, i.e. celestial bodies in motion in a gravitational field, such as the Earth and the planets and all celestial bodies.

Let us move on to the 1905 article.

The electrodynamics of bodies in motion

In the introduction, Einstein posits two postulates: To avoid any confusion, we quote him.

> *"It is known that if we apply Maxwell's electrodynamics, [.] we are led to an asymmetry which does not accord with the phenomena observed. [.] The mutual influence of a magnet and a conductor. [.] If the magnet is moving and the conductor is at rest, [the same result is obtained as] if the magnet is at rest and the conductor is set in motion."*

We have tried to make it short, you can check in the article translated into French as a reference. In reality, Maxwell has two equations depending on whether it is the lover (Faraday's equation) or the wire (Ampere's equation) that is being moved. They are identical to the first order because the difference is in the speed of the object moved, a few tens of meters per second in relation to the speed of light, 300 million meters per second

> *"In the text that follows, we elevate this conjecture to the rank of a postulate (which we will henceforth call the "principle of relativity") and introduce another postulate — which at first glance is incompatible with the first — that light propagates in empty space, at a speed V independent of the state of motion of the emitting body.*
>
> *[This is a property of waves, their speed depends on their support]*
>
> *It will be shown that the introduction of a "luminiferous ether" is superfluous, [.] In formulating any theory, we have to deal*

with the relationships between rigid bodies (coordinate system), clocks, and electromagnetic phenomena.

An insufficient appreciation of these conditions is the cause of the problems which the electrodynamics of bodies in motion are now confronted with. »

As for the second postulate, Einstein specifies that it contradicts **"at first glance"** the relativity of the motion of electromagnetic waves, of which light is a part.

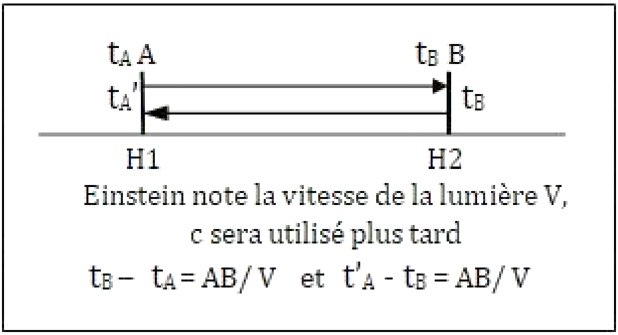
With the rejection of the ether, you have the explanation of why this article was violently criticized while the other three of the same year did not pose any problem, and that the one concerning the electrical effect of our solar panels and the proposal of photons earned him the Nobel Prize.

Einstein therefore applied the relativity of motion to electromagnetic phenomena. We will move on to his first chapter which we will limit to the first three paragraphs.

Kinematic part
§1. Definition of simultaneity

[.] If we want to describe the motion of a material point, the values of its coordinates must be expressed as a function of time. [.] If we say "that a train arrives here at 7 o'clock", it means "that the little hand of my watch that points exactly to the 7 and that the arrival of the train are simultaneous events". [.]

If an observer is placed at A with a clock, he can assign a time to events near A by observing the position of the hands of the clock, which are simultaneous with the event. If a clock is also placed in B [.] an observer in B can chronologically estimate the events that occur in the vicinity of B. [.] A common time can be defined, if we posit by definition that the "time" required by light to go from A to B is equivalent to the "time" taken by light to go from B to A.



For example, a ray of light starts from A at "time A", t_A, in the direction of B, is reflected from B at "time B", t_B, and returns to A at "time A", t'_A. By definition, the two clocks are synchronized if the outgoing time is equal to the return time

We assume that this definition of synchronism is possible without causing inconsistency, no matter how many points. [.]

So, with the help of some physical (thought) experiments, we have established what we mean when we talk about clocks at rest in different places, and synchronized with each other; and we have consequently established a definition of "simultaneity" and "time". [.]

In accordance with experience, we will make the assumption that the magnitude
→

$$\frac{2\overline{AB}}{t'_A - t_A} = V$$

is a universal constant (the speed of light in empty space). We have just defined time using a clock at rest in a stationary system. Since it exists in its own right in a stationary system, we call time thus defined "stationary system time".

§ 2. On the relativity of lengths and times

1) The laws according to which the state of physical systems is transformed are independent of the way in which these changes are reported in two coordinate systems (systems that are in uniform rectilinear motion with respect to each other).

2) Each light ray travels in a "stationary" coordinate system at the same speed V, the speed being independent of the condition that this light ray is emitted by a body at rest or in motion.

Let us have a rigid rod at rest; it is of a length L when measured by a ruler at rest. [.] Let the rod be given a uniform velocity v, parallel to the x-axis and in the increasing direction of the x. How long is the length of the moving rod? It can be obtained in two ways:

a) The observer with the measuring rod moves with the measuring rod and measures its length by superimposing the ruler on the rod, as if the observer, the measuring rod and the rod are at rest.

Note: This is paragraph 1

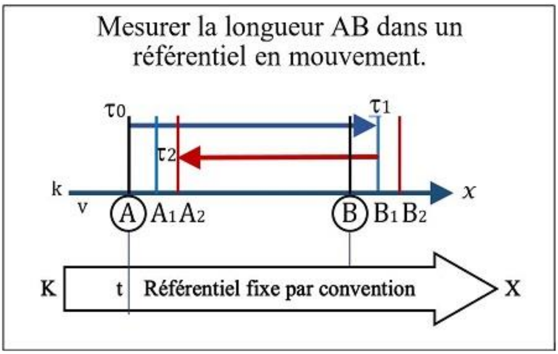
When we accompany an object, we are at rest in relation to it, and neither its dimensions nor the flow of time are modified

b) The observer [who looks at the rod moving at the speed v] determines at which points in the stationary system are the ends of the rod to be measured at time t, using the clocks placed in the stationary system.
According to the principle of relativity, the length found by operation a), [.] is equal to the length L of the rod in the stationary system.

The length found by operation b) can be called the "length of the rod (moving) in the stationary system". This length differs from L.

We understand: << the length found by operation a), [.] is equal to the length L of the rod in its stationary system. The length found by operation b) is the length of the rod seen in motion from the observer's frame of reference. We made a diagram with the rod in the k frame of reference. The observer is in the K frame of reference that we have shifted for better readability.

Let us imagine that there are two observers at the two clocks moving with them, and that these observers apply the synchronism criterion of § 1 to the two clocks.
At time t_A, a ray of light goes from A, is reflected by B at time t_B and arrives at A at time t'_A. Taking into account the principle of the constancy of the speed of light, we have:



On the outward journey the point B moves away at the speed v, resulting in a speed = V -v (Einstein wrote it). On the way back, point A approaches and the speed is then V + c. For Einstein, the speed of light in one frame of reference is V, but seen from another frame of reference with a speed of -v, the light moves away at a slower speed (V-v) and approaches at a higher speed (V + v). At this stage, the additivity of Galileo's velocities is not called into question!

The opinion of physicists specializing in the field would be welcome. The public believed that in a frame of reference seen in rapid motion, time expands, while Einstein explains that for the traveler who rests in this frame of reference, time is unchanged.

We have a hypothesis about the aether from Einstein's 1921 paper "The Aether and the Theory of Relativity." In 1938 in the book "The Evolution of Ideas in Physics" co-authored with Leopold Infeld, Einstein renounced the ether and asked never to pronounce this word again. But he pulled himself together and wrote that "the omission of a word from our vocabulary is not a cure, our troubles are actually too deep to be appeased in this way." So, for Einstein, the absence of ether is a problem. He had not been able to attribute to it any movement so that it would be immobile in all the frames of reference. All the frames of reference of celestial bodies are in free fall and matter falls at the same speed regardless of its mass, even a mass so small that it would currently be undetectable.

But before the existence of a medium for electromagnetic waves can be accepted, there must be agreement with what the consideration of relativity in these experiments really says.

We conclude that we cannot attach absolute meaning to the concept of simultaneity. Therefore, two events that are simultaneous when observed from a system will not be simultaneous when observed from a moving system relative to the first.

Note: At this stage we do not claim to have understood everything. Paragraph 3 reinforces our understanding of the process, but in an incomplete way. Things are not as simple as they seem.

§ 3. Coordinate and time transformation theory

Let us place, in the "stationary" system, two coordinate systems, [.]. In other words, a rigid rule with clocks in each system, everything being identical.

Let be an initial point of one of the systems (k) animated by a (constant) velocity v in the increasing direction of the x-axis of the other system, a stationary system (K) [.]. Any time t of the stationary system K corresponds to a certain position of the axes of the moving system.

Suppose that space is measured by the stationary ruler placed in the stationary system K, just as by the moving ruler placed in the moving system k, we therefore have the coordinates x, y, z (in K) and ξ, η, ζ, (in k). Let us measure the time t at each point of the stationary system using the clocks of the stationary system, using the method of light signals described in § 1. Let also be the time τ in the moving system [.] For each of the sets of x, y, z, t values that completely indicate the position and time of the event in the stationary system K, there exists a set of values ξ, η, ζ, τ in the system k. Now, the problem is to find the system of equations that connects these values.

Based on the homogeneity property that we attribute to time and space, the equations must be linear. If we set x' = x - vt, the point x' at the speed -v in the frame of reference k that moves at + v with respect to K is stationary in K and allows us to transfer the data from k to K. For a point at rest in the system k, there is a time-independent system of values x', y, z. Let τ be the function of x', y, z, t. We must express in equations the fact that τ is none other than the time given by the clocks at rest in the system k synchronized according to the method described in § 1. Let be a ray of light sent at time τ0 of the origin of the system k along the x-axis in the increasing direction of x' and which is reflected from this place at time τ1 towards the origin of the coordinates,
where he arrives at the time τ2. So, we have

$$\frac{1}{2}(\tau_0 + \tau_2) = \tau_1$$

(In §1 we have τ0 = tb -ta and τ2= t'a – tb. τ0 and τ2 are equal and τ1 is the mean)

If we introduce as a condition that τ is a function of the coordinates, and apply the principle of the constancy of the speed of light in the stationary system, we have

A t_2 : $\left\{t+\frac{x'}{V-v}+\frac{x'}{V+v}\right\}$ a τ_2 : $\tau\left(x',0,0,t+\frac{x'}{V-v}\right)$

$$\frac{1}{2}\left[\tau(0,0,0,t)+\tau\left(0,0,0,\left\{t+\frac{x'}{V-v}+\frac{x'}{V+v}\right\}\right)\right]=\tau\left(x',0,0,t+\frac{x'}{V-v}\right)$$

Il s'ensuit donc, lorsque x' est infiniment petit

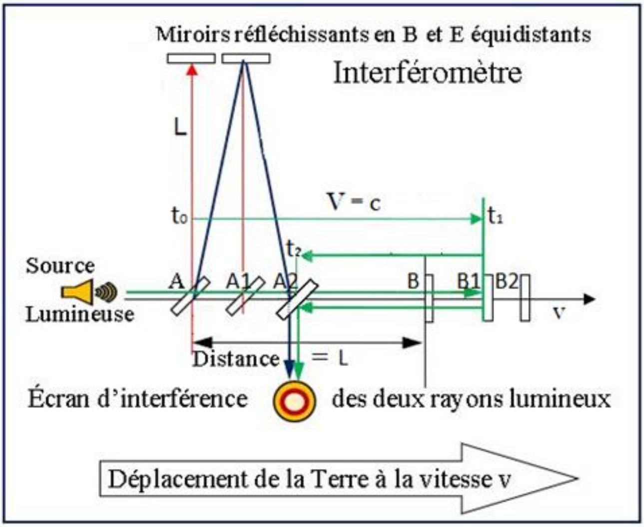
$$\frac{1}{2}\left(\frac{1}{V-v}+\frac{1}{V+v}\right)\frac{\partial\tau}{\partial t}=\frac{\partial\tau}{\partial x'}+\frac{1}{V-v}\frac{\partial\tau}{\partial t}$$

ou
$$\frac{\partial\tau}{\partial x'}+\frac{v}{V^2-v^2}\frac{\partial\tau}{\partial t}=0$$

At this point we will not detail Einsteins' calculations which lead to the same results as the Lorentz transformations, they are in Einstein's article that you can consult on the website of the University of Quebec in Chicoutimi:

https://classiques.uqam.ca/classiques/einstein_albert/Electrodynamique/Electrodynamique.pdf

We would like to draw your attention to an interesting point, the rigid rod in motion is the arm of the Michelson and Morley interferometer which moves at 30 km/s with respect to the reference frame of the ether and which does not detect any movement.



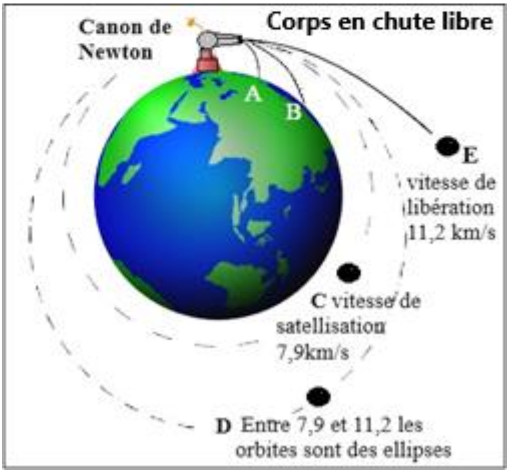
By decreeing that the speed of light is the same in all inertial frames of reference, Einstein demonstrates that the hypothetical contraction of matter does not exist and is only an illusion. It is the way we observe the electric field of an electron that causes it to change from spherical at rest to an ellipsoid contracted in the direction of motion as a function of its velocity that led physicists to believe that it contracted. Einstein tells us that motion shifts the moment of observation of a point A in relation to the time of observation of distant point B and that it is this shift that makes us believe in a contraction.

By using Lorentz transformations, we maintain an ambiguity. They should be called Einstein's transformations.

It is true that Poincaré finalized Lorentz's, but if he had had Einstein's first, he would have finalized them. Since they are identical, there would have been no confusion.

General relativity, Einstein's ether

In 1907, Albert Einstein made free fall in a gravitational field an inertial motion. The happiest idea he had, according to him. The kind of idea that is impossible when you know that the Earth revolves around the Sun, but it becomes obvious when you know why Aristotle was wrong and that his error of the Earth's immobility has persisted for more than 1800 years. To fully understand that celestial bodies are in free fall, the image of Newton's cannon helped us a lot. This will make specialists smile.



This, plus the equivalence between gravitation and acceleration led him to general relativity in 1915. It gives information on the time it takes for gravitation to propagate in space, and gravitational waves: the speed of light. Unfortunately, it does not say what carries this force. The physicists of the time came back with the luminiferous aether and Einstein realized that he needed it, or at least that he had to figure out how to deal with the problem.

In 1920, Einstein was admitted to the University of Leiden where his friend Lorentz was practicing. He gave a reception speech in which he restored the ether that he said he needed for general relativity and gravitational waves. There had been violent debates on this subject.

Einstein took up the essence of it and refused the immobility of the ether, which was the fatal error.

"The 'new ether' cannot be rigid or at rest,"

Under pressure from Philipp Lenard, Einstein endowed space with a state field that interacted with matter and was influenced by it.

"Interaction with matter" is our second clue. Matter and energy react with matter, this is gravitation!

Conclusion of the speech

"In summary, we can say, according to the theory of general relativity, that space is endowed with physical properties; and therefore, that the ether exists. [...] A space without ether is inconceivable, not only would the propagation of light be impossible, there would even be no possibility of existence [...] of spatio-temporal distances [...] However, the notion of movement should not be applied to it. »

Part Two

A hypothesis that would interest Eintein and that would confirm that the speed of light is the same in all inertial frames of reference

New hypothesis for ether

At this point, we offer you a quite astounding hypothesis **"at first glance"** as Einstein said about the constant speed of light throughout the universe, his second postulate that finally prevented him from finding the motion of the aether that he had proposed.

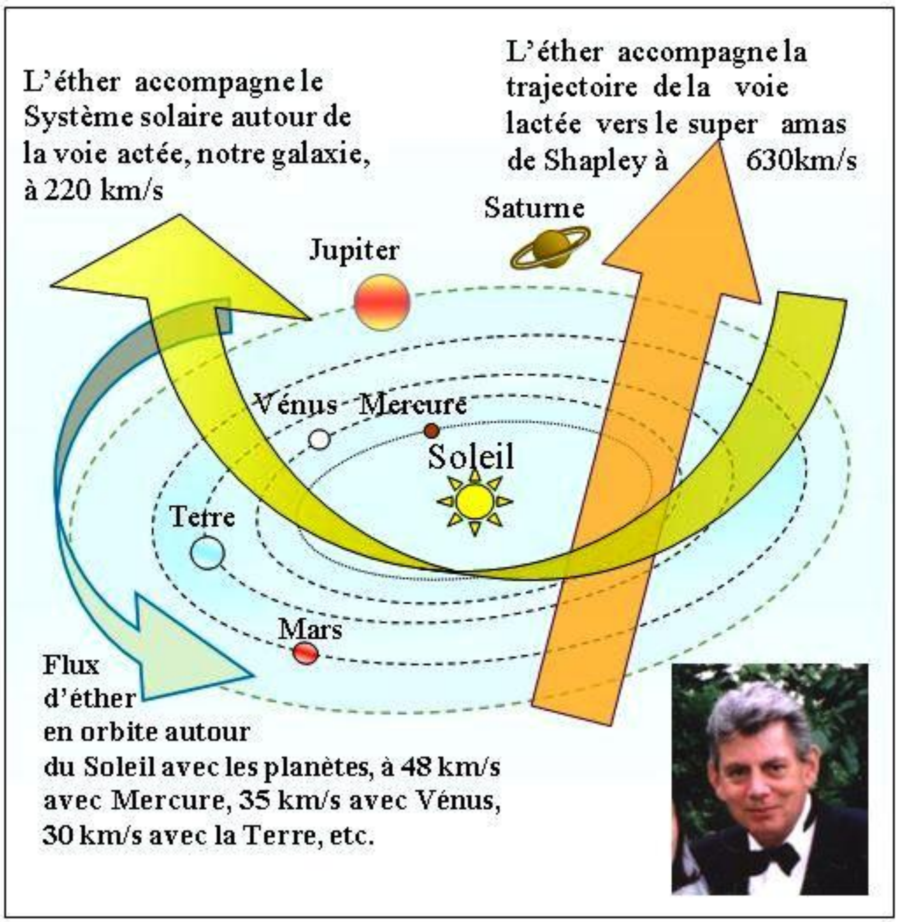
Suppose that the ether, mass, energy, or both, obeys the laws of gravitation. In relativistic language, "the ether follows the geodesics of space-time", and therefore accompanies all bodies in free fall and falls at the same speed, independent of their masses.

Near the Earth, locally, the ether is immobile in the Earth's frame of reference. And this is true for all celestial bodies.

The ether accompanies the Earth like the planets, stars or galaxies.

Einstein's ether is in free fall with all the celestial bodies in the universe. No friction. In addition, it accompanies each celestial body whose attraction also attracts it. As a result, the speed of light is the same in the frame of reference of each celestial body. Einstein's second postulate is unambiguously validated.

Would it be so easy and simple?



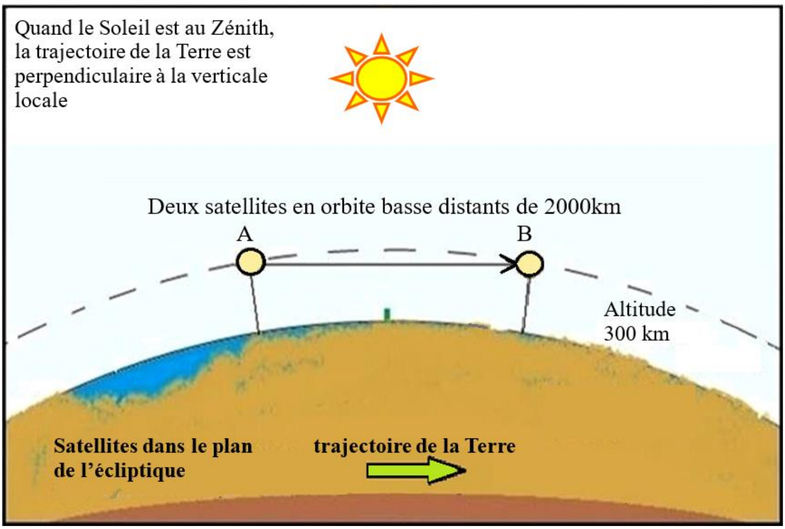
Too simple, if this is proven in a short time everyone will say that it was obvious. Well no, a medium whose movement adapts everywhere in the universe is astounding, and Einstein himself, who had all the data, couldn't find it. Nevertheless, this discovery, if validated, is his right.

Experiments to be carried out

To check whether the aether accompanies the Earth, we can use a frame of reference moving close to the Earth with sufficient speed for the aether wind accompanying the Earth to be detected. This frame of reference must be devoid of masses capable of dragging the ether with it.

In his 1905 article Einstein studied the measurement of a rod AB in his own frame of reference, and then from another frame of reference that observes the frame of reference of the rod that is in motion relative to it, which is, by convention, reputed to be stationary. To check whether the ether accompanies the Earth, it is sufficient to use a frame of reference moving close to it with sufficient speed for the generated aether wind to be detected. This frame of reference must be devoid of mass capable of dragging the ether with it.

Satellites in low orbit, in the plane of the ecliptic.

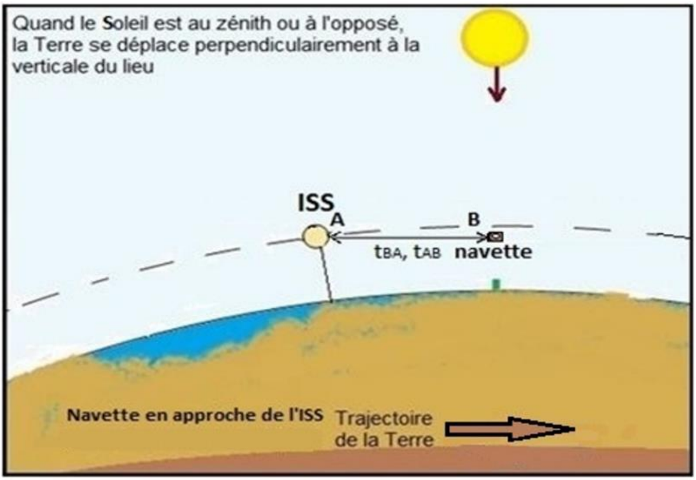


In the same orbit, 2000km apart and we measure the time taken by light to go from A to B and then back. If the ether accompanies the

Earth, but not the AB frame of reference, the time to go will be more or less different from the time back. If this is the case, it will be proof that the ether accompanies the Earth but not satellites, otherwise the hypothesis will be rejected.

Probe in the Earth's orbit in the opposite direction

The simplest



Use the space station and an approaching shuttle at the time when their positions are closest to Earth's path

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Translated into French in December 2012. Formal permission granted on December 13, 2012, by the translator of the French version, who wishes to remain anonymous, to publish this article in Les Classiques des sciences sociales.

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