Thought experiments that disprove the theory of relativity

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Abstract

Special and general relativity are *apparently* both extremely well proven – by their 'consistent' mathematics, and by many physical experiments and astronomical observations! But the theory of relativity contains several inconsistencies, and furthermore it predicts a physical reality that is *impossible*, which I will show several examples of in this paper.

The speed of light

A thought experiment about *the speed of light* and the so-called *'circular Sagnac effect'*:
Imagine a thin tube, shaped into a *perfectly* circular closed ring, which is at rest in an inertial frame. In the first experiment, light is sent around the ring, from the same point, in different directions and at the same time. It is found that the two light beams return to the starting point at the same time. Then the ring is set in rotation (in the same plane as the ring) until it has reached a certain rotational speed, after which light beams are again sent around the ring, in the same way as in the first experiment. An observer who is at rest relative to the ring measures that they do not reach the starting point on the ring, at the same time.

Then imagine that the tube is extremely long – let's say *at least* 10 billion light years (in principle it could be "*infinitely"* long) – and that it is divided into 1 meter long sections. Furthermore that the rotational speed of the ring is 1/5 of the speed of light, or higher. – Since all sections of the tube are exactly identical, the experimental conditions must be exactly identical in all sections (we assume that there are no gravitational influences, apart from the extremely weak gravitational field of the ring). It can then be *deduced* (but not directly measured [1]) that the two counter-propagating light beams *must* move at *significantly* different speeds in *all* the sections – otherwise they would not reach back to the starting point (on the ring) at significantly different times!

[1] As experts know, it is not possible to measure the one-way speed of light – only the two-way speed!

Since each individual section is only 1 meter long (or shorter), it can be perceived as being *"perfectly" straight*, and that it is at rest in an inertial frame, since no inertial forces, which may affect the individual sections, will be measurable! And no *acceleration* either, in the time it takes the light to move through a section (or for a significantly longer time). So, the effect must also exist in a section that is 100% straight and which does not accelerate at all!
Or, put another way: if if the speed of the two opposing light beams (in the ring frame) were the same in all sections of the ring, then the rays *would* reach back to the starting point at the same time!

If the effect is not due to *acceleration* of the individual sections, then it cannot be due to acceleration *as a whole*, either! So, **the conclusion must be that the 'circular Sagnac effect' is not due to acceleration, but due to that the speed of light is different in different inertial frames!** [2]

[2] According to *Lorentz ether theory* **[1]** it is not possible to find out the *true* speed of electromagnetic waves in relation to a measuring device, as long as the speed of this device, in relation to the ether rest frame, is not known.

Discussion

It is well known that clocks in a rotating frame cannot be properly synchronized, and some physicists claim that this is the cause of the effect – but that argument doesn't hold, since the Sagnac effect is measured with only *one* clock, which is constantly exposed to the same physical conditions (e.g. acceleration) during the circular motion!!

Others claim that the Sagnac effect is due to *difference of path lengths*. But it is only in the non-rotating frame that this explanation holds – because in the rotating frame there is *no* difference in path length! The only thing that can explain the time difference in this frame is different speed of light in the two directions, in all the sections!!

Let us calculate a concrete example, where the length of the tube (circular ring) is 300 million km, and the rotational (tangential) speed is 5000 km/s. – According to *Wikipedia* **[2]** the time difference can be calculated with the following formula:

$$\Delta t = t_1 - t_2 = \frac{4\pi R^2 \omega}{c^2 - R^2\omega^2}$$

which gives the result: **33.3426** sec.

But the effect can also be calculated by taking into account that the local speed of light is different in the two directions (i.e. the speed is 295000 km/s in one direction, and 305000 km/s in the other). When the tube is divided into 1 million sections of 300 km each, it gives a time difference of: **0.0000333426** sec., per section – and thus the same total result as with the Wikipedia formula!

According to Lorentz ether theory (LET), the real speed of light, and the ether, cannot be detected by physical experiments, due to *unavoidable* measurement ‘errors’, and if Lorentz and many other physicists of the time (e.g. A. S. Eddington **[3]**) were right, it will *never* be possible to demonstrate the real speed relative to the ether.

Wikipedia:
“Another, completely different attempt to save "absolute" aether was made in the Lorentz–FitzGerald contraction hypothesis, which posited that *everything* was affected by travel through the aether. In this theory the reason the Michelson–Morley experiment "failed" was that the apparatus contracted in length in the direction of travel. That is, the light was being affected in the "natural" manner by its travel through the aether as predicted, but so was the apparatus itself, cancelling out any difference when measured.”
https://en.wikipedia.org/wiki/Luminiferous_aether#Einstein's_views_on_the_aether

A *New Scientist* article (2005): ”Lorentz’s theory is so similar to special relativity that it has passed the same tests.” **[4]**

My own research **[5]** has convinced me that it actually *will* be possible to measure / record e.g. Earth's movement through the ether in the future – and there are many indications that it could happen in a few years, or at least this century!

That it is not possible to measure the *one-way* speed of light, is really well explained in a YouTube video: *”Why No One Has Measured The Speed Of Light”* **[6]**

Lorentz length contraction

The next example concerns *'Lorentz contraction'* / *'Length contraction'*, which according to relativity experts is a so-called *coordinate dependent effect*, that depends on which reference frame the measurement is made in. With a simple thought experiment, I will show that special relativity (SR) actually predicts two *fundamentally different* Lorentz contractions!

Fig. 1 illustrates two 'wheels', where a measuring rod is attached to each spoke. Originally, both wheels were completely at rest in an inertial frame, **IF-1**, and then they were completely identical and circular. The measuring rods (which were also exactly identical) did not hang together, but merely touched each other. As can be seen, both wheels are now set in motion, although in different ways.

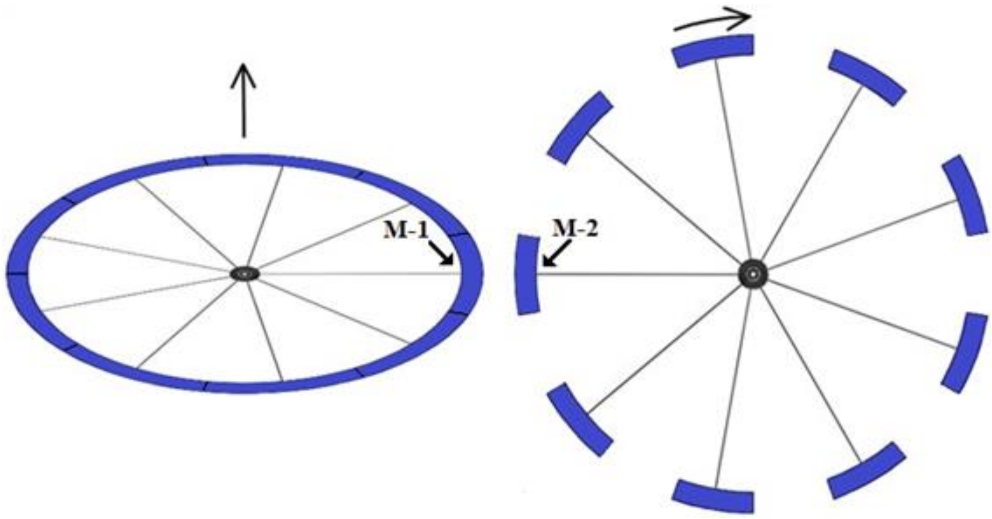

Fig. 1

The wheel on the left moves relative to **IF-1** in the direction of the arrow, but is at rest in **IF-2**. The center of the wheel on the right is at rest in **IF-1**, but the wheel rotates in the direction shown. At the moment shown in fig. 1, two of the measuring rods, **M-1** and **M-2**, are closest to each other, and they move (momentarily) in the “same” direction, at the same speed, and are both Lorentz contracted, according to SR. (It is assumed that the inertial forces to which the spokes and measuring rods are exposed, are counteracted by other forces, so only the length effects predicted by the theory of relativity appear - and furthermore that the rest lengths of the measuring rods are preserved!)

According to the normal interpretation of SR, **M-1** is only *coordinate* contracted, and *should* therefore take up exactly the same amount of space in the universe – *physically* – as before it was set in motion. But **M-2** has clearly been physically contracted, as gaps have appeared between the rods in this wheel, which is inevitable when the longitudinal axes of the spokes have not been contracted. (According to SR, the longitudinal axes of the spokes are not Lorentz contracted, as they are perpendicular to the respective directions of motion.)

If we assume that **M-1** and **M-2** are equal in length at the *moment* they are at rest relative to each other (as simple logic requires if their rest lengths are equal), then this must mean that **M-1** is also physically contracted – and also the entire left wheel! This would, of course, contradict the *special principle of relativity*, which requires the physical laws to be the same in all inertial frames, but this is actually what SR *must* predict, when it is *the wheel* that has been accelerated from one inertial frame to another! If, on the other hand, it is an *observer* who is accelerated to another inertial frame, so that the left wheel comes into relative motion, this obviously does not *physically* change the dimensions of this wheel (or how many wheels of the same size there would, in principle, be room (space) for in the universe).

There is another difference between coordinate-dependent and physical contractions: The first mentioned can happen instantaneously (because they are not physical effects – apart from the measurement results, which also LET predicts), while physical length changes *must* happen at speeds below the vacuum speed of light, since in such cases they are chain reactions between molecules in the substance. This knowledge can be used to test LET in relation to special relativity, what I have described in the paper: *"How to test Lorentz ether theory against the theory of relativity"* **[5]**

The special principle of relativity requires that the Lorentz contraction of the wheel is completely independent of whether it is the wheel or an observer that is accelerated to another inertial frame, on condition that the *rest dimensions* of the wheel are preserved (in that case it is the relative speed that is decisive). And therefore Lorentz contractions should in all cases only be coordinate dependent effects!

The contraction of measuring rods (when their rest lengths are preserved) along the edge of a rotating circular disc, relative to the (approximated) circle they formed before the rotation, and other similar situations, was the reason why Einstein concluded that the geometry is *non-Euclidean* in rotating reference frames (and in gravitational fields) – but what he (apparently) overlooked was that the measuring rods *must* have been *physically* contracted, so that an observer on a rotating circular disc cannot use them to measure the circumference of the disc accurately (i.e. in principle). It is not the circumference that has become larger, but the measuring rods that have become shorter! And therefore it is wrong to claim that the geometry is non-Euclidean in the rotating frame (unless you make it clear that the statement is a pure mathematical expression, that says nothing about the *physical* structure of space)!

Relativity's (inevitable) prediction of the *physical* contractions of measuring rods in “rotation”/'orbit', is not due to inertial forces or acceleration, which is realized if one imagines that the spokes are so long that the rods do not accelerate measurably, even if the orbital speed is close to that of light (what is possible in principle) – while at the same time making the rods so short (before the rotation starts) that their curvature cannot be measured.

That acceleration is irrelevant to the effect is also clear from a thought experiment that I used in the paper: *"Fundamental inconsistencies in the theory of relativity*" **[7]**. I reproduce here an illustration from this thought experiment (though modified on a single point):

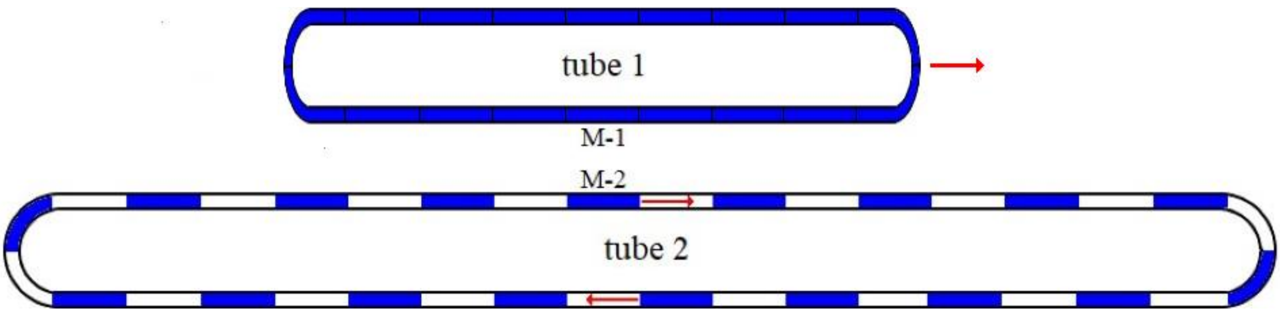

Fig. 2

The illustration shows two closed (and transparent) tubes, which in the initial situation were completely identical, and completely filled with measuring rods of equal length. The two tubes were then at rest in an inertial frame, **IF-1**, but the rods in tube 2 were then accelerated to such a high speed that their lengths were halved, as measured in **IF-1**. And here we assume that the entire tube 1 moves in the same direction and with the same speed as **M-2** (measured in **IF-1**) in the situation shown.

When tube 1 is Lorentz contracted in the relative direction of motion, to the same degree as **M-2**, we see some contraction effects that are quite similar to those seen in fig. 1. ***Physically***, the 4 straight sections in the two tubes are/should be completely equal in length (they still have the same rest lengths). However, since the rods in tube 2 are physically contracted, so that there *could be* room for twice as many as there is room for in tube 1, it is clear that *if* the entire tube 1 is only *coordinate depending* contracted (as the generally accepted version of SR predicts), **M-1** and **M-2** cannot be equal in length when they are at rest relative to each other!!

But actually, SR *must* predict that rods and other objects become physically contracted, when accelerated from one inertial frame to another (as I have shown in **[7]**).

Tube 2 takes up the same amount of space in the universe – physically speaking – as before the rods in it were accelerated up to relativistic speeds, and therefore the rods in this tube *must* take up physically less space in the universe, after their speed change! The physical length of **M-2** has been *halved*, just as if you had split it into two equal parts (while at rest in tube 2) and then removed one part!

If the Sun was accelerated to an inertial frame, that had a sufficiently high speed, relative to Earth, it would take up physically less space in the universe, than the Earth, according to SR!!

Such an effect is *fundamentally* different from a coordinate dependent effect. No matter how much, or how, an observer changes his state of motion, this - alone - will never change how many rods there is room for in a tube (or the total length of the rods in relation to the tube) - of course! If the apparent shortening of **M-1** in fig. 1 and 2 is due to that an observer has been accelerated to a different inertial frame (after first being at rest relative to this rod), then such a contraction effect will be as *'non-physical'* as the apparent size change of an object, when an observer changes his distance to it!

That SR predicts Lorentz contractions which are contradictory, I have shown several examples of in the paper: *"Questions concerning the foundation of the theory of relativity"* **[8]**, i.a. the following:

> "Imagine that we have two very long and completely straight tubes, and that one of them is inside the other, so it can move freely, only in the longitudinal direction. The inner tube is accelerated to a certain speed, which is then kept constant. An observer, O, moves in the same direction as the inner tube (as measured in the inertial frame of the outer tube), also at a constant speed. The two tubes then have the same speed, but in opposite directions, measured in his inertial frame. If O is then accelerated to the same relative speed as the inner tube, this will, according to SR, result in that the outer tube, and thus also the space inside it, will be (coordinate-dependent) contracted, as measured by him. However, during the same acceleration process, the inner tube, and the space inside it, is *expanded*, as measured by O, according to SR (because the relative velocity between this tube and O becomes smaller and eventually 0)!!
> This shows that *the same space* can expand and contract, *at the same time*, *measured by the same observer*, according to SR!??"

A more unambiguous illustration of what SR predicts about the ratio of **M-1**'s and **M-2**'s *physical* lengths, after the rods in tube 2 are accelerated, can be seen in the unedited version of the illustration I used in the previously mentioned paper, shown here in fig. 3:

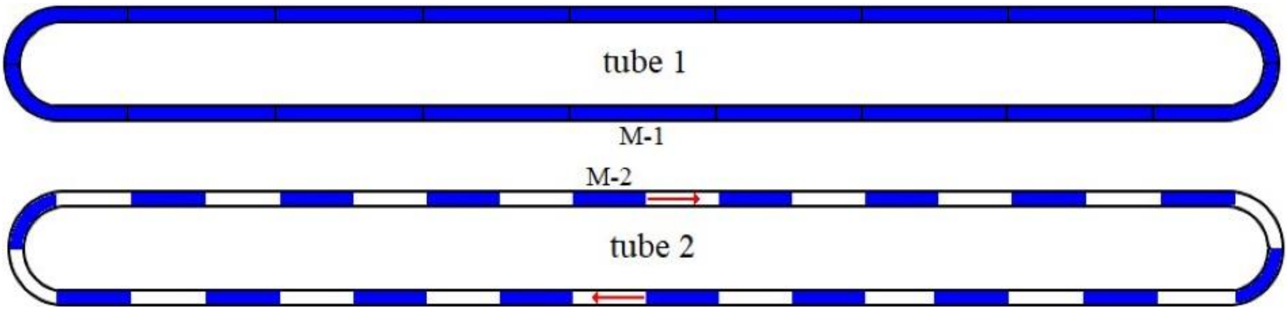

Fig. 3

Tube 1 and 2 are at rest relative to each other, and their sizes are exactly the same, but the rods in tube 2 move through this tube, and are therefore Lorentz contracted, not just measured in **IF-1**, but physically. So even though **M-2** has retained its measured rest length, it *must* have become physically shorter than **M-1**! Nevertheless SR predicts that an observer at rest relative to **M-2** will measure that **M-1** is shorter than **M-2**!??

We can take this situation as a *starting point* for a new thought experiment where **M-2** is accelerated back to the inertial frame **IF-1**, where it came from. This must then result in **M-2** being *physically* contracted once again, if the rest length is preserved.

(That this indeed is the case is because SR predicts that the laws of nature are the same in all inertial frames. And since SR predicts such effects in *some* cases, it must predict them in *all* cases where physical objects are accelerated from one inertial frame to another, and the rest lengths are preserved)!

An observer in **IF-1** can then directly compare the length of **M-2** with the length of **M-1** (which has always been in **IF-1)**, and must then necessarily get the result that **M-2** has become shorter than **M-1** [1], although **M-2** has preserved its rest length (and its *natural length*, at the temperature and pressure conditions in question), and therefore should have the same length as **M-1**, according to SR! – In other words: by starting from SR we arrive at the result that **M-2** has become physically shorter than **M-1**, even though the same theory *must* predict that the two rods will have the same length, when they are at rest in relation to each other again. *A genuine paradox!*

[1] **M-2** takes up less space in the universe compared to before it was accelerated.

If you think that it cannot be right that SR predicts something that is so clearly a paradox, I will recommend you to consider the consequence of **M-2** being physically *expanded* when it is transported from **IF-2** back to **IF-1**, so that **M-1** and **M-2** again have exactly the same length. Then there would apparently no longer be any paradox. On the other hand, SR would then have another problem: how do you explain that standard measuring rods (with identical rest lengths) in different inertial frames *do not occupy the same space in the universe, physically speaking?* How could a measuring rod (**M-2**) be physically shorter in **IF-2** than in **IF-1**, if the rest length is preserved?? That would be contrary to the *special principle of relativity*, and therefore also SR!

If you shorten a measuring rod by cutting of a piece, both the 'physical length' and the 'rest length' become smaller. However, if a measuring rod is accelerated to another inertial frame, **"**SR**"** [2] predicts that the physical length becomes smaller, when the rest length is *preserved* (as shown through those thought experiments).

[2] Not SR as currently interpreted by experts, but as I have argued, SR must necessarily predict physically contraction effects in some cases, if it is not to contradict simple logic!

Based on **fig. 3**: let us assume that the rest length of each measuring rods is 1 meter. Since there is room for 8 rods in each of the straight sections in tube 1, these sections must therefore both have a rest length of 8 metres. The same applies to the straight sections in tube 2, as the two tubes are physically identical.

Measured in **IF-1**, there is room for 8 rods and 8 gaps (/spaces) in each of the two straight sections of tube 2, in the situation shown. But how many rods are there room for, measured in an inertial frame **IF-2**, which is at rest relative to **M-2**, in that particular situation? Since the tube is in motion, measured in **IF-2**, it is Lorentz contracted (according to SR), and the coordinate lengths of the straight sections are both 4 meters. The rest lengths of the rods have been preserved, and therefore there must be room for 2 rods and 2 gaps in the section in which **M-2** is located. This means that the remaining 14 rods must be in the opposite (straight) section, measured in **IF-2** (we completely ignore the curved sections here, as they can be made “arbitrarily” short, in principle).

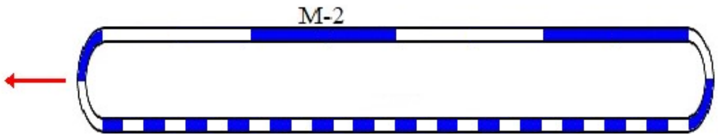

Fig. 4

The same conclusion can be reached in the following way: The starting point was that the speed of the rods in relation to the tube should be so high that their coordinate lengths were halved (measured in **IF-1**), and I calculated this speed to be (approx.): 259627 km/s. (at ***c*** = 299792 km/s.)

According to a pre-relativity calculation, the speed of the rods in the 'opposite' straight section – measured in **IF-2** – is equal to 259627 km/s + 259627 km/s, which *according to SR* gives approx. 296717 km/s. **[**$u = (v+u')/(1+vu'/c^2)$**]**

At this speed, γ is equal to approx. 7, which means there is room for 7*2 rods (the rods are 7 times shorter in the opposite section) + the same number of gaps in that section, measured in **IF-2**.

But doesn't that lead to a kind of imbalance, measured in **IF-2**? Not only are there more rods in one of the sections, but the masses of these rods must also be greater than their rest masses, according to SR. And when γ is equal to 7, this apparently imply that the rods in one section are 7*7 times heavier (coordinate dependent) than those in the other straight section!?

The question is, however, whether relative motion of a body causes increased gravitational influence on it, according to general relativity. On the Internet I found the following explanation:

....

“So how can this “mass increase” be understood? As usual, Einstein had it right: he remarked that every form of energy possesses inertia. *The kinetic energy itself has inertia*. Now “inertia” is a defining property of mass: more inertia means it's harder to accelerate, a given force accelerates it less. The other fundamental property of mass is that it attracts gravitationally. Does this kinetic energy do that? To see the answer, consider a sphere filled with gas. (And let's assume there's negligible interaction between the molecules, true for a dilute gas.) The sphere of gas will generate a spherically symmetric gravitational field outside itself, of strength proportional to the total mass. If we now heat up the gas, the gas particles will have this increased (relativistic) mass, corresponding to their increased kinetic energy, and the external gravitational field will have increased proportionally. (No-one doubts this either.)

So the “relativistic mass” indeed has the two basic properties of mass: inertia and gravitational attraction.”

https://galileo.phys.virginia.edu/classes/252/relativistic_mass.html

My comment: I agree with the conclusion. The theory of relativity *must* predict that the gravitational field around the sphere will become stronger when the speed of the gas particles increases (*however, this makes no sense if all speed is only relative*). If this is also in line with *reality* (which I suppose), I think it can be explained in a much more understandable way if you combine GR with an ether theory. As the temperature of the gas increases, its particles must necessarily also increase their average speed in relation to the ether 'rest frame', which, according to LET, will cause their inertial masses to increase. Since these are *physical* effects, according to LET, it seems *plausible* that the particles' overall gravitational field also becomes stronger.

“The word "mass" has two meanings in special relativity: *invariant mass* (also called rest mass) is an invariant quantity which is the same for all observers in all reference frames, while the **relativistic mass** is dependent on the velocity of the observer. According to the concept of mass–energy equivalence, invariant mass is equivalent to *rest energy*, while relativistic mass is equivalent to *relativistic energy* (also called total energy).

The term "relativistic mass" tends not to be used in particle and nuclear physics and is often avoided by writers on special relativity, in favor of referring to the body's relativistic energy. In contrast, "invariant mass" is usually preferred over rest energy. The measurable inertia and the warping of spacetime by a body in a given frame of reference is determined by its relativistic mass, not merely its invariant mass. For example, photons have zero rest mass but contribute to the inertia (and weight in a gravitational field) of any system containing them.”

Source: ***Mass in special relativity – Wikipedia***

But back to the question of whether the different number of rods in the two straight sections of tube 2 *should* cause a (in principle) *measurable* imbalance in **IF-2**. As a thought experiment you could measure whether the two sections are equally heavy or not. Suppose that the whole of tube 2 rests on the three (brown) beams shown in fig. 5, and that around the tube there is a very homogeneous part of a gravitational field that originates from a source far from the tube (possibly a 'supermassive black hole'). The three beams could possibly maintain their positions relative to the source, using rocket engines.

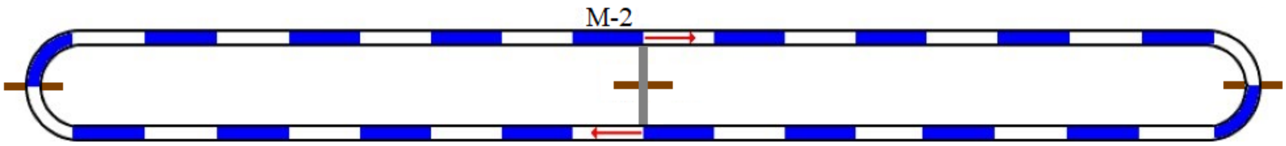

Fig. 5

(If the tube was so long that it was significantly deformed by its own weight and that of the rods, it might be necessary to support the tube with many beams, which were themselves supported by exhaust from rocket engines – but here we disregard this conceivable complication.)

This imaginary weight is made so that only a small difference in weight between the two sections will cause the tube to tip, thereby revealing which section is heavier. According to the theory of relativity, there should be complete equilibrium measured in **IF-1** (in which the tube is at rest), and if this is true, it means that no weight difference will be measured, no matter how fast the rods move through the tube. – But judged by an observer in **IF-2**, there will apparently be a very large weight imbalance, and I cannot see that there can be other relativistic factors in this frame, which dissolve the apparent paradox (even if it should be demonstrated that relative motion of a body does not change the gravitational influence from other sources of gravity, according to the theory of relativity).

The forces that affect a body ‘at rest’ (relative to the center of gravity) in a gravitational field are *inertial* forces, according to GR. The body accelerates relative to the local inertial frames because these are 'free falling', according to this theory. The same must therefore apply to the rods shown in fig. 5, because these rods also accelerate in relation to the local inertial frames. One can therefore argue that it is not the strength of the objects' own gravitational fields that are decisive for their weight in such cases, but their *inertial* masses, according to the theory of relativity.[1] And since SR and GR predict that a body's inertial mass changes if an observer changes its velocity relative to it, I must conclude that: measured in **IF-2**, the rods in this thought experiment *are* **49** times heavier in the 'opposite' section, according to a GR based prediction!

[1] However, it should be added that according to the *equivalence principle*, gravitational mass is equal to inertial mass, so this must mean, that you cannot increase one of them without simultaneously increasing the other.

Different perceptions of *simultaneity* in **IF-1** and **IF-2** cannot (in my estimation) have any bearing on the predictions of the experiment in question, since the gravity from the source (and the number of rods in each of the two sections) must be constant throughout the experiment! So apparently it is only a question of how many rods there are in each of the two sections, and how heavy they are! (But what do experts conclude?)

As a thought experiment (and perhaps also as a real experiment?) you could send e.g. protons around a ring-shaped tube, and measure how much pressure these particles exerted on different parts of the tube. Newtonian physics and the theory of relativity would then predict that the pressure on the parts of the tube that were closest to the Earth would be *slightly* higher, than the pressure on the parts that were furthest from the Earth (caused by gravity). The theory of relativity would further predict that: the higher the speed of the particles, the higher the effect would be. – But if one imagined that an *observer* was accelerated up to 'relativistic speeds', then of course that would not change how high the pressure on the different parts of the tube was, even though the masses of the particles (and the tube) would change, as measured by this observer (predicted by SR)!!

Proposal for a new test of the equivalence principle

In the paper *"How to test Lorentz ether theory against the theory of relativity"* I described a new way to test *the equivalence principle*, and thus GR. I am reproducing it here, as I have some additions.

A logical consequence of the correctness of the equivalence principle must be that it is the acceleration of the measuring device, relative to the local inertial frames that creates both gravitational time dilation and gravitational redshift. During the acceleration the observer / measuring device constantly changes inertial frame, which according to GR / SR results in changed *simultaneity perception* / *measurements*.[1] In free fall there is no acceleration relative to the local inertial frames, according to GR, and therefore there should also be no gravitational redshift, or measurable difference in the rate of 'time', or the speed of light, in a sufficiently homogeneous "field" area (which, measured in free fall, contains no gravitational field, according to GR.

[1] However, in a natural gravitational field this "rule" can only apply in sufficiently homogeneous field areas, because a clock in the center of a globe (where there is no 'gravity'), runs physically slower than a clock located far away from the globe and other sources of gravity. The gravitational time dilation effects must then (according to GR) be due to the accelerations of the inertial frames between the two clocks.

If you could place an atomic clock at the Earth's center of gravity, and compare its ticking rate with the ticking rate of an atomic clock on the International Space Station (*here disregarding the speed effect*), then, according to experts, you would find that the clock at the center of the Earth runs slower. Since the effect is not 'symmetrical', and since none of the clocks are accelerating relative to the local inertial frames (according to GR), I can only conclude that GR predicts that a clock which is placed lower in a gravitational potential, than another, is running *physically* slower (at least if the clocks are at rest relative to each other)! A clock on the International Space Station runs physically slower than a clock located far away from significant gravitational fields (if the two clocks are at rest relative to each other). A clock that is located 10 meters below the space station runs physically slower than a clock which is inside the space station.

A Wikipedia article describes the effect this way:

"Gravitational time dilation is at play e.g. for ISS astronauts. While the astronauts' relative velocity slows down their time, the reduced gravitational influence at their location speeds it up, although at a lesser degree. Contrarily to velocity time dilation, in which both observers measure the other as aging slower (a reciprocal effect), gravitational time dilation is not reciprocal. This means that with gravitational time dilation both observers agree that the clock nearer the center of the gravitational field is slower in rate, and they agree on the ratio of the difference." **[https://en.wikipedia.org/wiki/Time_dilation]**

Therefore I conclude, that if we have two atomic clocks (that are at rest relative to each other) inside the International Space Station, then the clock which is closest to Earth will be measured to run at the slowest rate.[1] However, if this is true, it will contradict the equivalence principle,[2] and thus GR, since according to this theory you should not be able to measure gravitational time dilation inside a freely falling closed room, if the gravitational field is sufficiently homogeneous inside it [3] (and thus without tidal forces of importance).

[1] If the space station is at an altitude of 400 km. above Earth's surface, and the height difference of the two atomic clocks is 2 meters, my calculations show that the difference in their times will be 4E-13 sec., after 30 min. – what should be possible to measure with some of the best atomic clocks.

[2] There are several versions of this principle, but it will certainly be contrary to *'the strong equivalence principle'*.

[3] Wikipedia: "So the original equivalence principle, as described by Einstein, concluded that free-fall and inertial motion were physically equivalent." **[**Has been deleted from the article in question!**]**

I conclude that – ***at least*** – **'the strong equivalence principle' thereby already has been *disproved***, but think that it should be tested in any case, e.g. on the *International Space Station*, where two synchronized atomic clocks, placed at different heights (e.g. 2 meters difference), should be able to clarify whether there is a difference in the rate of the clocks, even if they are in free fall. The clocks are first synchronized and after a while (e.g. 10 min.) their times are compared. In my opinion, you cannot be absolutely sure that it is sufficient if you measure that there is no gravitational redshift (/ blueshift) – this is no guarantee that there is no gravitational time dilation, since the device which measures the frequency during free fall, accelerates relative to the 'universe' / ether, which may (?) have an impact on the outcome.

But a question could be: is the gravitational 'field' inside the ISS *homogeneous* enough to test GR in the way I suggested? To clarify this I have made some calculations:

Suppose that on the ISS we have two atomic clocks that are placed with a height difference of **2** meters. The distance from the lower clock to the Earth's center of gravity is set to 6770 km. Based on that, I have calculated **g** to be approx. 8.696809497 m/s² at the lower clock, and approx. 8.696804359 m/s² at the uppermost. (**GM**: 3.986E+14; **c**: 299792000 m/s)

Gravitational time dilation at the lower clock is calculated to approx. 6.5510143E-10 [using the formula: $\mathbf{1-\sqrt{(1-2GM/rc^2)}}$] and to approx. 6.5510124E-10 at the uppermost. The precisely calculated difference is: **1.9353065E-16**

If we imagine that the two clocks were in a **completely homogeneous** field (due to *proper acceleration*, far away from significant gravitational sources), with a height difference of **2** meters, then the acceleration at the lower clock in the inhomogeneous field (8.696809497 m/s²), would cause a gravitational time dilation of **1.9353070E-16** (calculated using the formula: **gravit. time dilation = g*h/c²**) – The acceleration at the top clock (8.696804359 m/s²) would cause an effect of: **1.9353059E-16**. The difference between the two effects (homogeneous fields) would then be approx.: **1.1E-22** (and therefore much smaller than the effects themselves).

Based on these results, I conclude that the inhomogeneity of the gravitational field, in the area between the two clocks, is so small that you can ignore it in the calculations! So, according to the equivalence principle, the result of such an experiment on the International Space Station *should be* the same as if the experiment were carried out so far away from significant gravitational sources, that there would be ***no*** (measurable) gravitational potential difference in the laboratory at all, and therefore no gravitational time dilation! (According to GR experts, it is the difference in the gravitational potential between the two clocks that determines how large the gravitational time dilation effect will be, regardless of how inhomogeneous the field is in the area in question.)

> "According to the general theory of relativity, gravitational time dilation is copresent with the existence of an accelerated reference frame. Additionally, all physical phenomena in similar circumstances undergo time dilation equally according to the equivalence principle used in the general theory of relativity."
>
> ***Gravitational time dilation – Wikipedia***

According to GR, objects in freefall are *not* accelerating physically (no 'proper' acceleration). To the extent that the gravitational field is uniform in the area in question, two free falling clocks at different heights will run at the same rate, if you can trust this principle – which also predict that when gravitational time dilation *is* present, it is not the measuring device itself that is affected, but the device will *measure* that clocks located higher or lower in the gravitational field, run faster or slower than they would without gravitational fields of importance – in accordance with the fact that these *predicted* effects are *coordinate dependent*.

That is, however, contrary to a recognized and widely used method for calculating gravitational time dilation: $\boldsymbol{t_0 = t_f\sqrt{(1\text{-}2GM/rc^2)}}$. * This formula (which is based on the *Schwarzschild metric*) is used to calculate the extent to which 'clocks' are *affected* by this effect, and you can then (disregarding any speed-based time dilation) directly compare how fast the clocks run, relative to each other, according to these calculations – which will show the *ratio* between the two times ($\boldsymbol{t_0}$ and $\boldsymbol{t_f}$), whereas the formula I used: $\boldsymbol{1\text{-}\sqrt{(1\text{-}2GM/rc^2)}}$, directly shows how big the time dilation effect is. (Both formulas actually require a *single*, *spherical* and *non rotating* gravitational 'body', if the calculations are to be completely accurate.)

* https://en.wikipedia.org/wiki/Gravitational_time_dilation

As the formula shows, it is the position (height) of a clock in the field, together with the mass of the field source / sources (and the gravitational constant, and the speed of light), that determines to what extent the clock is affected by gravitational time dilation. The formula is in accordance with scientific measurements, which show that gravitational time dilation's *physical* influence on a clocks ticking rate is completely independent of whether the clock is 'at rest' in a gravitational field, or it is in free fall. (For example, clocks in GPS satellites and on the International Space Station are affected by gravitational time dilation, even though they are in free fall!)

So one cannot in *all* cases (within the limits, set by experts) rely on the principle of equivalence! And when it comes to measurements made in free fall, you can't count on, that it is the difference in the gravitational potential that is decisive!

In order for the equivalence principle to be in accordance with reality, it would require that in all cases they were only *coordinate-dependent* (non physical) effects, due to that the measuring devices accelerated in relation to the local inertial frames – and were thereby constantly transferred to new (relative) 'time-zones'. For example is this the theory of relativity's explanation for the *physical* time dilation effect in the twin paradox, which according to both SR and GR is due to that the traveling twin is affected by *acceleration*, when he turns the spaceship and travels towards the Earth. But such a *coordinate-dependent* time effect absolutely cannot explain the physical time difference that appears when the two twins meet again! (I have elaborated on this argument in: *"Fundamental inconsistencies in the theory of relativity"* **[7]**.)

In the best-known version of the *twin paradox* (*TP*), one twin makes a long space journey and then returns to his brother on Earth. It then turns out that the traveling twin has aged significantly less than his brother. An alternative TP (let's call it *TP2*) could be a scenario in which one twin is in a long-duration circular orbit (using rocket engines) around his brother, who is located on a space station, far away from gravitational sources of significance. It is well known that even in such a case, relativity predicts that the traveling twin will age coordinate *independent* less than its brother. Both GR and SR can be used to calculate the magnitude of the effect. According to GR, the effect can be explained by that the the orbiting twin is in an artificial gravitational field, and is therefore "affected" by gravitational time dilation. (Apparently GR predicts that it is his brother on the space station who is (*coordinate-dependent*) 'affected' by the field that the traveling twin feels, while his own aging is completely unaffected by the field - but that makes no sense to me!)

Two clocks at different altitudes, here on Earth, are both affected by gravitational time dilation, but to different degrees. Such effects are coordinate *independent*. [“Contrarily to velocity time dilation, in which both observers measure the other as aging slower (a reciprocal effect), gravitational time dilation is not reciprocal…” (*https://en.wikipedia.org/wiki/Time_dilation*)]. They are as physical as the time difference in TP and TP2. Yet relativity experts claim that they are coordinate-*dependent* effects, since an observer deep in a gravitational field cannot, by *purely ‘local’* experiments, measure that his/her clock runs differently than in areas far from gravitational sources of significance – or measure that the speed of light is reduced. Only by comparing the ticking rate of one's own clock with clocks located at other heights in the gravitational field, can the effect be established. But the travelling twin in TP2 cannot either, by *purely ‘local’* experiments during his orbital journey, measure that his own clock runs physically differently than if the clock had not been affected by time dilation! That this is nevertheless the case is *unambiguously* established if you compare the timekeeping of the clocks, after the traveling twin has made many orbits around his brother.

Because gravitational time dilation is a *physical* phenomenon, and because the formula: $t_0 = t_f\sqrt{(1\text{-}2GM/rc^2)}$ can be used on clocks that are in free fall, as well as clocks that are not, it can be stated that two clocks at different heights on the International Space Station will tick at different rates – contrary to the principle of equivalence! (But in any case, I think that it should be tested in real experiments, where it is also investigated whether *gravitational redshift* exists in a free-falling space station.)

Sources

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