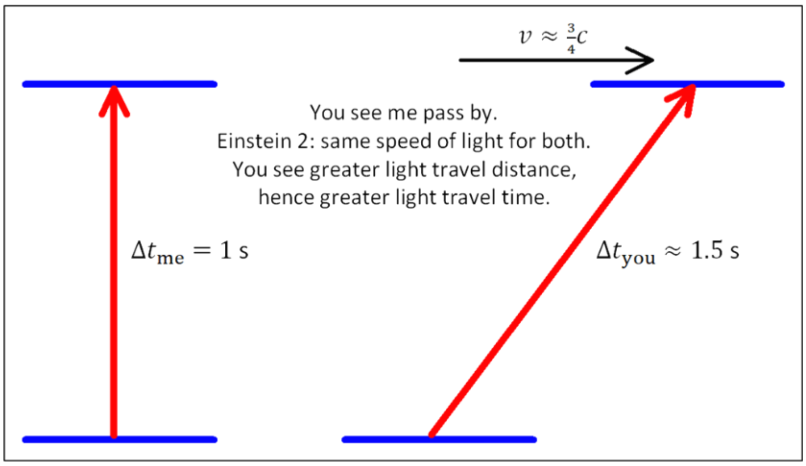
Albert Einstein did not pick anything from thin air, but he concluded from facts of experience (which of course include experimental results). One very import *conclusion* of his is that the *speed of light* be a *universal constant* that has identically the very same value for each and every observer, independent of any velocity of the light source w.r.t. him (which is called his 2nd postulate) and also totally independent of any mutual velocity of two observers (his 1st postulate: all laws of nature are identical to all observers as perceived from their own perspectives, no matter how fast something (or someone) else is passing by).

He drew this conclusion from the fact that Michelson & Morley measured the very same *speed of light* in each and every direction, independent of Earth's fast[1] orbital motion around the sun, which nobody understood. Einstein said: *I don't need to understand it, it's a fact from which I can draw a plausible conclusion*. And then this conclusion (the *speed of light* be a universal constant) immediately explained the measurement! In http://henk-reints.nl/astro/HR-speed-of-light.pdf I explain this in more detail.

It means that if you and I pass each other at a mutual velocity of say half or three quarters of the *speed of light*, we still measure exactly the same speed (w.r.t. ourselves) of one and the very same single ray of light. If you cannot conceive this, you should please take it for granted. It simply ***IS*** how light behaves.

Now consider an undeformable rod with a lamp on one end and a detector on the other. A ray of light will need some time to travel along the rod from lamp to detector. Suppose I am passing you at half or three quarters of the *speed of light* and I am holding this rod perpendicular to my movement how you observe it. Then *you* see my rod moving sideways while the ray of light is travelling from lamp to detector, so you see the light follow an oblique path whilst crossing. Basic geometry tells us that an oblique crossing is longer than a perpendicular one (have you too been taught to not cross a road at an angle?).



Because of the constancy of the *speed of light*, you see the light travel this oblique longer path at ***THE*** *speed of light*, which to you is exactly precisely identically pleonastically the same as to everyone, no matter whomever's velocity. Since travelling a greater distance at the same velocity takes more time, ***you*** measure a longer ***time span*** than what ***I*** measure for the very same ray of light to travel from the very same lamp to the very same detector.

As a direct result of the fundamental constancy of the *speed of light*, we now obviously no longer have the same experience of *time*. This is called ***time dilation***. *Time dilation* is the most important aspect of Einstein's ~~theory~~ conclusion of relativity. *Time dilation* means we each have our own perception of *time*, each from our own perspective.

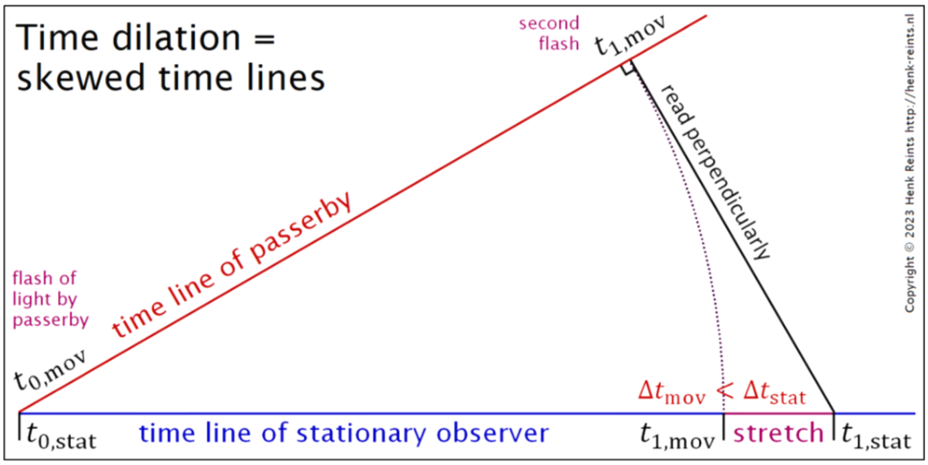
THAT is what Einstein's conclusion of relativity is all about:
we perceive everything from our own point of view, including *time*.

We observe everything with respect to ourselves. *That* is what is meant by *relativity*. *Geometrically*, there is *nothing wrong* about saying the sun orbits the earth. It *is* what we actually observe. *Physically* however, Earth & Sun both orbit their common centre of mass and since the sun is 330 000 times heavier than the earth, this barycentre is located inside the sun, at merely 450 km from the sun's actual centre. *That* is why physicists (as well as those silly people we call astronomers) say the earth actually orbits the sun.

[1] The speed of the earth around the sun is nearly 30 km/s ≈ 1 earth diameter in merely 7 minutes and a few seconds.

You have *your* time and *I* have *mine*. *Time* is something **individual**, not universal. ***THE*** time does **not** exist, but *your* time and *my* time. *Time* is something **individual**, not universal. ***THE*** time does **not** exist, but *your* time and *my* time. *Time* is something **individual**, not universal. ***THE*** time does **not** exist, but *your* time and *my* time[2]. If you get this, the universal constancy of the *speed of light* will no longer be a mystery. We both measure it in our *own time* and any difference lives right there. What *does* exist is ***THE*** *speed of light*.

An now we're going abstract: we both have our own *time line*. To *me*, *my* time line is always completely normal and it goes straight ahead from *my* perspective. To *you*, *your* time line is always completely normal and it goes straight ahead from *your* perspective. But when we pass one another at an extremely great velocity, your *time line* becomes skewed to me and my *time line* becomes skewed to you. Since the *time lines* themselves are of course invisible, we cannot truly observe this skewness, but it is fully comparable to the obliquity of the path of the ray of light that you observe when watching it going from lamp to detector. The fact that you measure a longer *time span* for this traversal than what I measure is called *time stretching*. It is a perspective distortion due to the abstract skewness of our *time lines*, but just the other way round as for visible entities, where angled things appear shorter.



Important: *time stretching* applies to *time spans* between events that take place at the passerby, e.g. emission by *my* lamp and absorption by *my* detector as observed by *you*. From your perspective, I'm the passerby. The passerby's *time spans* last longer for a stationary observer than for this passerby himself. **When we pass one another at great velocity, *you* see more time between *my* events than what *I* perceive myself, and *I* measure longer time spans between *your* events than what *you* observe yourself.** Read this last sentence once again!

Now suppose you see me (and my detector) go faster than light. From your perspective, the light from the lamp, travelling at ***THE*** universal *speed of light*, can of course not keep up with the detector, which goes faster, so you'll never ever see it reach my detector. But to me, the detector has zero velocity, so I see the light hit the bull's eye. **I see a perfect hit and you see a catastrophic miss of exactly the same ray of light going from exactly the same lamp towards the very same detector.** My dear mother taught me (in Dutch): *Wat niet kan is nog nooit gebeurd*. It means: something impossible has not yet ever happened. Galileo Galilei wrote: *Due verità non posson mai contrariarsi*, two truths cannot ever contradict one another.

ANY premise that implies an impossibility MUST be false. The premise was: *suppose you see me (and my detector) go faster than light*. That must be false, so you cannot see me go faster than light, no matter how flashingly clever I may be. It would lead to a severe contradiction. The *speed* ***limit*** *of light* directly follows from the constancy of the *speed of light*.

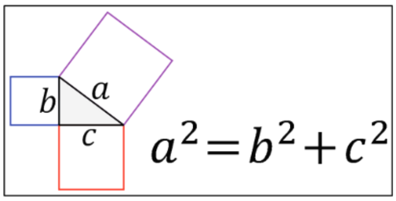
It should be obvious that the light *does* have a speed component towards the detector, so its obliquity *MUST* be less than 90°. This means our *time lines* cannot ever diverge by 90° or more. That's another way to say the *speed of light* is unattainable and can certainly not be exceeded.

Please memorise: *time* is not universal; we each have our *own time*. *Time dilation* = *your* and *my* time are not necessarily equal; the faster we pass each other, the more they will deviate from one another. *Time*

[2] Repetitio est mater studiorum -- rehearsal is the mother of learning. Zogt zhe nokh a mol un take nokh a mol.

stretching = *you* see more time between *my* events than *I* see myself, and v.v. The greater our mutual velocity, the larger the *time dilation* will be, since the skewness of our time lines increases with velocity. Would we approach the *speed of light*, *time stretching* will climb towards infinity. All of this is due to the ***universal constancy of the speed of light***: all observers always measure the very same *speed of light*, no matter their mutual velocity, which Einstein did *not fabricate* but *conclude* from *facts* of experience.

We now have the path of the light along the perpendicular rod as observed by me, the oblique path of the light as observed by you, and the sideward displacement of the rod as seen from your perspective. Do you see these form a right-angled triangle? And did you ever learn some well-known theorem about such triangles?



We convert between *your* and *my* time using the Pythagorean theorem! But isn't that some nasty formula containing squares? And have you ever learned that a square can never be negative? Would our mutual velocity exceed the *speed of light*, we would have to solve an equation containing a negative square, which is impossible (in the image above, c^2 would become larger than a^2 yielding a negative b^2). There we have the mathematical reason why the *speed of light* cannot be exceeded.

Now the two of us are together without any mutual velocity, thus being one single so called stationary observer. We witness a wise wingless witch with a wig and a widget which switched her bewitched wiper for a wicked broom, willingly waving with the wind at a weird *relativistic speed*. The latter means it is high enough for *time dilation* to become significant. Of course she won't go off course, but fly rectilinearly. She holds her broom straight in the direction of motion and for some obscure reason we must know the length thereof. We must measure from our own perspective, with non-moving instruments, and she will definitely not stop to let us measure her broom. How can we achieve this measurement? **STOP!** THINK before you continue reading!

By counting tiles we can use the pavement as a stationary ruler, and we both have identical perfect clocks. You measure in how much time the witch travels a given amount of tiles, thus determining her velocity. I measure how much time her broom takes to pass the tip of my nose. Then we multiply the duration of the broom passage by the witch's velocity and bingo! We have measured the length of the moving broom, using only stationary instruments.

But from the witch's point of view, *we* are passing *her*. *She* measures — in *her* time! — how long it takes for *us* to pass her broom, as seen from *her* perspective. Starting and stopping our clocks are *our* events, not *hers*, so *she* observes *time stretching* of the time span *we* measure for the broom passage. It means *she* measures a longer time span than *we* do. Then *we* measure a shorter time span than *she* does, hence a shorter broom than what *she* measures. For *her*, the broom is a non-moving thing, completely normal. Therefore it is shortened to *us*! Please reread this paragraph until you get it.

As a direct result of *time dilation*, moving objects appear shortened in the direction of motion, as seen by a stationary observer. This is called *Fitzgerald–Lorentz contraction,* named after the two persons who independently came up with this idea when Albert Einstein was at the age of 10 to 13. But both George Francis Fitzgerald and prof. Hendrik Antoon Lorentz picked it from thin air. Lorentz litterally said[3]: "Ik heb slechts één middel kunnen *bedenken*" = "I could *think up* just one thing". Einstein on the other hand, drew *conclusions* from *facts of experience*. He later described this surmise by Fitzgerald & Lorentz as an "ad hoc assumption that only appeared as an artificial means to save the theory". Nevertheless, Einstein showed (i.e. *concluded* from *facts* without fabricating anything) they had come up with something correct.

[3] https://babel.hathitrust.org/cgi/pt?id=mdp.39015073715875&seq=82&q1=bedenken Verslagen der Zittingen van de wis- en natuurkunde afdeeling der Koninklijke Akademie van Wetenschappen van 26 Juni 1892 tot 28 April 1893: gewone vergadering der afdeeling natuurkunde op Zaterdag 26 November 1892, pp.74-79: "De relatieve beweging van de aarde en den aether", @p.76

To a stationary observer, moving objects appear shorter. And we are going abstract once again: the fast moving broom (or whatever object) is skewed towards the direction of *time*. But the broom itself is a non-abstract physical object, so I'll call this *half abstract* skewness. Of course this contraction is a perspective distortion as before, but this time it is simple shortening just like any oblique physical object appears shorter. The obliquity itself is however invisible, since it is towards *time*.

As said, moving objects appear shorter to a stationary observer. And the faster the witch flies, the more her broom will become contracted as seen by the stationary observer. But can it become shorter than zero? Of course not. That's why the witch can't fly faster than light.

Now suppose you are driving a car and you are speeding above all limits, i.e. at half or three quarters of the *speed of light*. From *your* point of view, the street is passing *you* at that velocity. Isn't that similar to the witch's broom? To *you*, the street will be contracted. Yes, the street becomes shorter when you go really fast (but you'll lose the game if you say that to a cop who wants to fine you). The faster you drive, the shorter the street becomes and just like the witch's broom, it cannot become shorter than zero.

Would you drive at exactly the *speed of light*, this *length contraction* will have shortened the street to precisely zero, i.e. from *your* perspective, your travel distance has become zero! What would that mean to your travel time? It has also become zero! When travelling at the very *speed of light*, both your travel distance and time are zero as perceived by *you*. Then you'll arrive at exactly the very same moment as when you depart. Would it then still make sense to try going faster? Superluminality is not only impossible, it is a pointless concept. Ceterum censeo superluminalitatem esse delendam.

Do you realise the very same applies to light itself? It *does* travel at the *speed of light*, doesn't it? Light experiences exactly zero travel time and distance. From its own perspective, it is an instantaneous energy transfer at zero distance. Even if it comes from a distant galaxy in deep space. From *our* perspective, it takes what we call the *light travel time* to traverse the *light travel distance*.

Summarizing, we can say that both the *time line* and the *spatial line* (physical length in the direction of motion) of a fast moving object become skewed in the directon of time, which is called *time dilation*. The greater the velocity, the greater this skewness, approaching 90° if the velocity nearly equals the *speed of light*. The skewness itself is abstract since it is nothing spatial. Its effect is that we observe *time stretching* and *length contraction* of fast moving things. Both effects are only observed by the stationary observer. Please note: from his own perspective, the passerby is the stationary one and then *you* are the passerby!

Until now, I have silently presumed that our mutual velocity never changes. But now suppose you see me pass by while I am accelerating, i.e. my velocity is increasing. Then the skewness of *my* time line as it is from *your* perspective increases with my velocity. And my velocity increases while time is progressing. But isn't the progress of time the same as "walking" the time line? So as I travel along my time line, it becomes more and more skewed to you. Doesn't that mean it will bend? **When I am accelerating, my time line becomes curved to you!**

Now look at an accelerating witch's broom. Like the *skewness of time*, the *broom's obliquity* will also increase as it passes with a growing velocity. Doesn't that imply the broom's spatial line (in the direction of motion) becomes **curved as well?** But all skewness and curvature are in the (4^{th}) dimension of *time*. Not directly visible.

When a passerby is accelerating, both his time line and his spatial line (in the direction of motion) become curved to the stationary non-accelerating observer. ***This* is the curvature of spacetime you may have heard about.** But it is abstract curvature. You cannot truly see it, but its effects are of course increasing *time stretching* and *length contraction* as perceived by the stationary non-accelerating observer.

While accelerating, you gain extra velocity with respect to your initial state, i.e. when you were not yet accelerating. So during acceleration, you build up a velocity with respect to when your acceleration was zero. When acceleration equals nought, we call it *inert motion*. Acceleration yields a velocity with respect to your own *inert motion* you would have had without acceleration. Acceleration yields a velocity with respect to your own *inert motion* you would have had without acceleration. Acceleration yields a velocity with respect to your own *inert motion* you would have had without acceleration. Got it?

In his Philoſophiæ Naturalis Principia Mathematica, Sir Isaac Newton published his laws of motion. The 1^{st} law says that velocity does not change unless a force is exerted and the 2^{nd} law says the change in motion is proportional to this force. In mathematical notation: $F = m \times a$ where a is the acceleration, m is the mass of the object (amount of stuff it consists of), and F is the force. In essence, to *accelerate* a massive body, a *force* must be exerted on it, and if a *force* is exerted on it, it *accelerates*. It means ***acceleration*** has ***everything*** to do with ***force***. *Inert motion* now means that *no force* is exerted and *spacetime* becomes *curved* if a *force* **is** exerted. ***Curvature of spacetime*** is due to a ***force***. Spatial curvature (towards the direction of *time*, as said) applies to spatial lines in the direction of this force.

And then Einstein got the happiest thought of his life, which in ***my*** words is: *it does not matter where a force comes from, be it an engine or gravitation*. Have you ever felt a slight change of your own weight in a lift? Would you not have known you were in a lift, you might just as well have been on another planet where gravity slightly differs from how it is on Earth. It's indistinguishable.

Einstein's happiest thought has suddenly turned relativity into a theory of gravitation! And what do you *actually feel* as far as gravity is concerned? Do you really *feel* Earth *pulling* you towards it? Or, presuming you are currently sitting on a chair, do you *feel* (with your bottom) that the chair prevents your free fall by *push*ing you *up*wards? It's the latter! *That* is how you *feel* your weight! The chair *push*es you *up*wards, just like the aforementioned lift floor as it *accelerates* upwards. Essentially, there is *NO* difference!

When you fall from a height of just one metre ($39.\overline{3700787401574803149606299212598425196850 39}$ inches), you'll hit the floor at roughly 16 km/h (10 mph). Would it feel essentially different if you rush against a wall at that speed? Not before (i.e. only when) you hit the target, be it the floor or the wall, you will feel a *force* (ouch!). Actually, Einstein's happiest thought was that *a person in free fall does not feel his own weight*, from which he concluded that to a blindfolded observer, *acceleration* and *gravitation* are indistinguishable. It is called the ***equivalence principle***.

Would the upward force by the chair (essentially the resilience of Earth itself) not be there, you would fall freely (which doesn't hurt at all) until you hit something (which can be very harmful). Were Earth fully penetrable without any resistance, you would freely fall all the way down to its centre without feeling any force. Didn't we call it *inert motion* if there is no force? *Free fall* is *inert motion*, i.e. without any force being exerted. Contrary to what you may have learned, free fall involves *NO* force! But the chair *does* exert a force. **Free fall means no force is exerted, being stationary in a gravitational field requires a force** (please read that at least twice). *This* is what's meant by "*gravitation is not a force*". Gravitation yields a free fall where ***no force*** is exerted. It's the *chair* (or better: the underground's resilience) that exerts a force that prevents this free fall.

This force implies you are seemingly accelerating, so you have gained some velocity w.r.t. your own inert motion you would have had without it. It may seem odd, but when you sit on a chair, you actually have a(n upward) velocity with respect to your own (fictional) downward inert motion. Let's call it ***gravitational pseudo velocity*** or ***gravocity*** (the latter is a name I coined myself). It equals the *free fall velocity* (but upwards, so actually the so-called *escape velocity*) and it causes ***time dilation***, hence ***time stretching*** and ***length contraction***!

What was explained before gravity entered this story is called ***kinematic time dilation***, which is due to *mutual velocity* together with the **constancy of the *speed of light***. This ***gravocity*** now causes what we call ***gravitational time dilation*** (it is even called *gravitational* if you are accelerating by means of an engine). Therefore we have both *kinematic* and *gravitational time stretching* as well as *kinematic* and *gravitational length contraction*. And the force that keeps you stationary in the gravitational field yields a pseudo acceleration, hence ***gravitational curvature of spacetime*!**

The *time span* between for example two flashes of light occurring in a strong gravitational field appears stretched to a distant observer experiencing way less gravity. And vice versa: here on Earth we see shorter time spans between successive ticks of the atomic clocks in satellites, where Earth's gravitation is weaker. Due to *gravitational time dilation*, we see those clocks tick faster then what the satellite itself sees.

Furthermore, the satellite has an orbital velocity, causing *kinematic time stretching* as well. Its speed causes earthlings keeping their feet firmly on the ground to perceive the satellite's clock ticking slower than what the thing itself observes.

The satellite feels less gravity, hence we see it tick faster, and due to its velocity we see it tick slower. These effects do however not compensate one another.

For GPS (Global Positioning System), this *kinematic time stretching* is roughly 7 microseconds per day, and the *gravitational time stretching* is about –45 µs/d (mind my minus sign I silently applied to thy tiny time, bright guy; I find thy fine time nicely slightly tighter). Together, they add up to –38 µs/d. Mwah! A few millionths of a second during an entire day. Is that to be taken seriously?

Yes! GPS is based on differences in signal travel time, so this time deviation must be multiplied by the *speed of light*, which is ca. 300 000 km/s = 300 million m/s ≈ 1.08 billion (Dutch: miljard) km/h. Those millions compensate each other, yielding a drift in the location determined by *YOUR* satnav of 475 metres per hour(!) whilst you just stay put. Of course this has been corrected by design (they interrupted the launch countdown to adjust the tick rate of the on-board clocks 😃). Altogether, it means the accuracy of GPS (8 metres in so called open field) confirms Einstein's *conclusion of relativity* each and every time you are using your satnav.

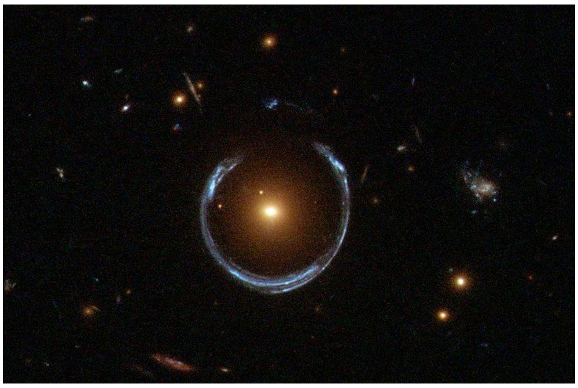
Now we combine Newton's 2nd law: $F = m \times a$ (*force* equals *mass* times *acceleration*) with the *speed **limit** of light*. Acceleration cannot ever make a velocity exceed this limit. If a force keeps being exerted, it leaves room for only one thing: the *acceleration decreases* (ultimately to zero!) and the object's *mass increases* as the velocity gets closer to the *speed of light*. The energy put into an object is no longer reflected as a greater *velocity*, but as a greater *mass*! The latter grows by the very same factor as *time stretching*, leading to one of the most well-known formulas ever: $E = mc^2$. *Energy* and *mass* are in fact one and the same. Mass can be seen as some condensed form of energy, or energy as some abstract quantity into which mass can change. Conversion from mass to energy is what makes the sun shine, nuclear power plants produce electricity, and unfortunately also atomic bombs explode.

Finally, this document is not about black holes. Well, one thing: you probably have learned they got some *event horizon*. Simply said, that is the distance to a massive object where the *escape velocity* equals the *speed of light*, so nothing - not even light - can escape from within it. Nothing comes out, but you can fall into it (only from your own perspective; due to *gravitational time stretching*, a distant observer will never see it happen). That's why it's called a black hole. You can fall into it, but even light cannot come out. One can also say it is where the gravitational curvature of spacetime approaches the uncome-at-able skewness of 90°. Its gravity is so strong that it so to say deviates our observations by practically 90° away from itself, so we essentially know nothing about a black hole's interior.

And now you should read http://henk-reints.nl/astro/HR-Twin-paradox-slides.pdf in which I make clear that the standard interpretation of time dilation is wrong (especially clocks ticking slower due to kinematic time dilation), since it yields the so called *twin paradox*, which is not a *paradox* at all, but a contradiction.

Some daily life confirmations of Einstein's ~~theory~~ conclusion of relativity:

- the Global Positioning System (GPS) has, as aforementioned, been corrected for relativistic effects, thus making it an accurate and usable system at all;
- the velocity at which electrons flow through a current-carrying wire causes length contraction, thus seemingly increasing their count per unit of wire length, which in turn causes them to exert an increased electric force on other electric charges; this extra force is called **magnetism** (which also is the driving force of electric motors);
- the yellow color of gold (instead of silvery white like most other metals) is due to the relativistic speed of the outermost electron in the gold atom, contracting its orbital length, thus changing the energy level such that it absorbs blue light and reflects its complementary color;
- the fact that mercury is a liquid metal at room temperature is caused by relativistic contraction of the innermost electron orbit, causing shrinkage of the entire atom, thus pulling the outer electrons more tightly to the atomic nucleus, which in turn makes them more reluctant to bind to other atoms;
- particle accelerators (like the Large Hadron Collider at CERN) make particles approach the speed of light very closely and if they had not been designed with relativity in mind, the things would not work at all;
- gravitational lensing: curvature of spacetime bends rays of light that pass a heavy mass like a lass without any glass in the grass of a morass in the Alsace, or the impasse of brass in a crevasse at Montparnasse, smart-ass...



the "horseshoe" is due to gravitational lensing.

🕐🕑🕒🕓🕔🕕🕖🕗🕘🕙🕚🕛

Quid est ergo tempus?
Si nemo ex me quærat, scio.
Si quærenti explicare velim, nescio.

Then what is time? When nobody asks me, I know.
When I would like to explain it however, I do not know.
Aurelius Augustinus Hipponensis (CCCLIV – CDXXX), Confessiones 11.14

🎼♪♩♪♬♫🎻

Music is the only form of art that entirely takes place in time.
Jan Berendes (1936-2011).

Some relativistic formulas for those who might be interested.

(Suffixes: "stat" = as perceived by stationary observer, "mov" = as seen by moving passerby).

Speed of light: $c = 299\,792\,458$ m/s (Lat.: **c**eleritas = speed)
velocity: v (Lat.: **v**elocitas = speed)
dimensionless velocity: $\beta = v/c$

kinematic time stretching: $\Delta t_{\text{stat}} = \Delta t_{\text{mov}}/\sqrt{1-\beta^2}$ $\therefore \boldsymbol{\beta \leq 1 \therefore v \leq c}$
kinematic length contraction: $l_{\text{stat}} = l_{\text{mov}} \cdot \sqrt{1-\beta^2}$ (Fitzgerald-Lorentz contraction)

velocity addition: $\beta_{\text{tot}} = \frac{\beta_1+\beta_2}{1+\beta_1\beta_2}$ $\therefore \beta_1 < 1 \wedge \beta_2 < 1 \rightarrow \beta_{\text{tot}} < 1$
\& $\beta_1 = 1 \vee \beta_2 = 1 \rightarrow \beta_{\text{tot}} = 1$

relativistic Doppler effect: $\frac{\lambda_{\text{stat}}}{\lambda_{\text{mov}}} = \sqrt{\frac{1+\beta}{1-\beta}}$

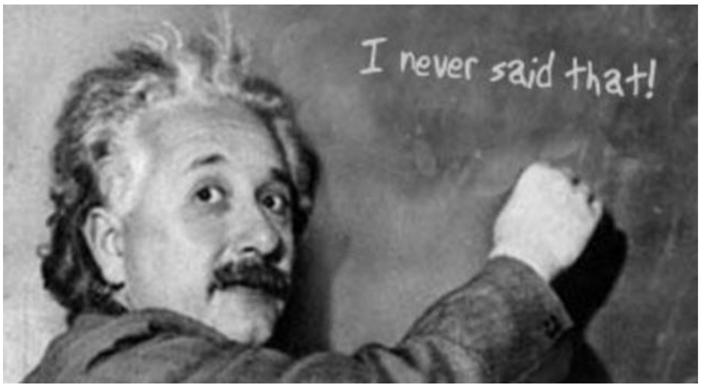
kinetic energy: $E_{\text{k}} = mc^2\left(\frac{1}{\sqrt{1-\beta^2}} - 1\right) \rightarrow \infty$ if $\beta \rightarrow 1 \therefore \boldsymbol{v < c}$ **if** $\boldsymbol{m > 0}$
energy/mass relation: $E = mc^2$ Einstein's original: $\Delta E = \Delta mc^2$
relativistic mass of moving body: $m_{\text{stat}} = \frac{m_{\text{mov}}}{\sqrt{1-\beta^2}}$

gravitational constant: $G = 6.67430 \times 10^{-11}$ N·m^2/kg^2

distance to some mass M: r (**r**adius of orbit)
radius of BH's event horizon: $r_{\text{S}} = 2GM/c^2$ (Schwarzschild radius)
equivalence principle: r_{S}/r is equivalent to β^2 (Einstein's happiest thought)

gravitational time stretching: $\Delta t_{\text{distant}} = \Delta t_{\text{local}}/\sqrt{1-r_{\text{S}}/r}$
gravitational length contraction: $l_{\text{distant}} = l_{\text{local}} \cdot \sqrt{1-r_{\text{S}}/r}$

("local" = as perceived on the spot where gravitation applies,
"distant" = as perceived at great distance with zero gravity).



One of the most misquoted persons in the world...