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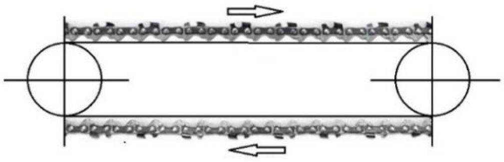
Special theory of relativity
Length contraction

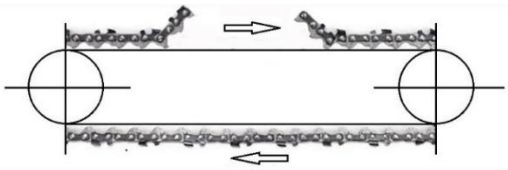
The chainsaw paradox

The chainsaw paradox is a thought experiment that does not occur in nature. No chain can move at anything close to c. It relates solely to the length contraction of the special theory of relativity. Everything beyond that is ignored. We ignore the time of acceleration and deceleration. It is undisputed that the chain breaks because it heats up and burns up due to the friction on the blade. However, that has nothing to do with length contraction. It is also undisputed that there are complications because the upper half of the chain is pushed and the lower half of the chain is pulled, although this does not require simultaneity. However, that has nothing to do with length contraction. Just as the chain breaks at the turning points due to acceleration, deceleration and centrifugal force. But that has nothing to do with length contraction either. To exclude irrelevant effects, the experiment only relates to the straight part of the chain while it moves evenly at approximately c. Since the chain contracts along its entire length, you can take any section. Let's take the straight section. In this section, neither the chain nor the sword can tell who is moving and who is at rest. The principle of relativity does not allow this. One could even relate only individual terms to the length contraction or only individual atoms of a term. - And simultaneity or the lack of simultaneity plays no role in the chainsaw paradox. Only one gear is driven. The second one runs freely.

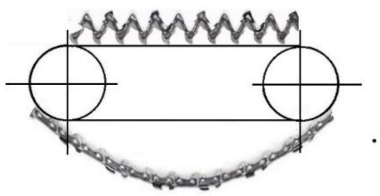


Both the chain and the sword are in the cutout between the two axes of rotation in both systems either at rest or in a uniform, straight-line movement at approximately the speed of light. According to the principle of relativity, there is no difference between rest and uniform linear motion. Nothing in the world can distinguish between these two states. The thought experiment refers to a phase where the chain has already reached its speed of approximately c and is therefore moving uniformly in a straight line across the middle part of the sword.

In the sword system the chain is shortened. The chain breaks.



In the chain system, the sword is shortened. The chain sags.



Reality only knows one process. Either the chain breaks or it sags? There are many perspectives, but there is only one reality. What follows the 3-fold contraction chaos? Does the chain break or does it sag? Can a connected chain have 3 different lengths? - Can 3 times pass at different speeds in a connected chain? Reality does not depend on what external observers observe. External observations do not interfere with internal reality.

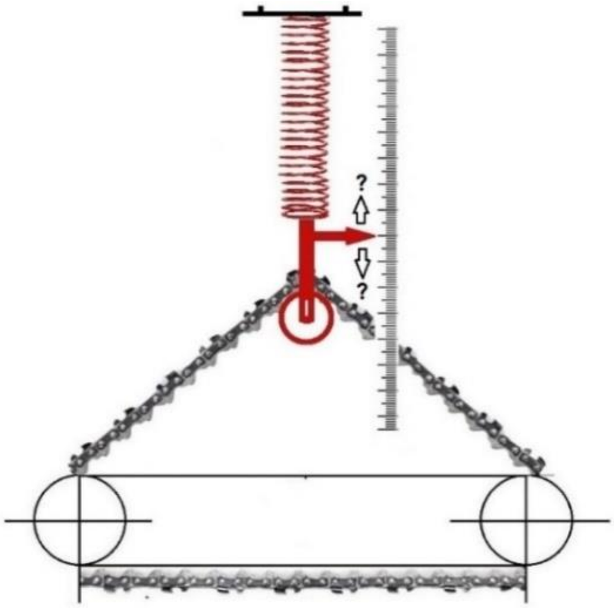
The length chaos

A buyer buys a chainsaw. The total length of the chain is 1 m. The total circumference of the bar is 2 m. The buyer asks the seller how the chain can fit on the bar? The seller replies: *"The chain just has to move fast enough, because then the bar gets shorter for the chain and then it fits on the bar."* - *"Can you demonstrate it to me,"* asks the buyer? *"Only if you have until tomorrow,"* says the seller, *"because due to time dilation it takes about a day for the chain to fit on the bar."*

The lower links in the chain say to the upper links in the chain: *" But you're short compared to us.* The upper links say to the lower links*: "Strange, but we were just about to say the same thing to you."* Say the sword*: "Quiet, you short limbs." - "Hello, what happened to you? You are wider than you are long,"* say the limbs to the sword.

Will the chain break or sag? Either way, a chain tensioner will prevent both and keep the chain on the bar. The position of the chain tensioner is recorded in a measuring device.

Situation 1) Both systems, the bar and the chain, are at rest relative to each other. The measuring device measures the position of the chain tensioner.



Situation 2) The chain accelerates to 0.9 c and subsequently moves evenly along the middle sections. The chain tensioner keeps the chain taut and undamaged on the bar, whatever effects occur in all systems.

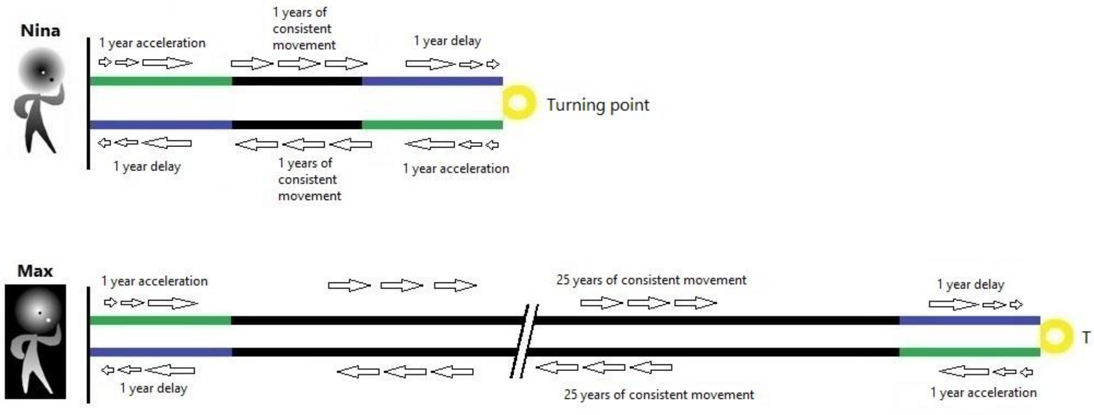
System 1) Sword relative to the upper and lower chain.
System 2) Upper and lower chain relative to the sword.
System 3) Upper chain relative to the lower chain.
System 4) Lower chain relative to the upper chain.
Every system is at rest or in uniform motion relative to all other systems. The principle of relativity does not allow any distinction. Inertial systems don't change anything.

What value do all systems read on the scale?

Mathematics answers this question. But is there a reality behind this answer?

The chain tightener asks the chain: *"How does it feel to be 100%, 44%, and 10% long?"* The chain says: *"My length is always 100%. What the others see doesn't concern me."* The chain tightener says to the sword: *"How does it feel to be 100% and 44% long?"* The sword says: *"My length is always 100%. What the others see doesn't concern me."* The chain tightener then says: *"Okay, if everyone is the way they've always been, then I'll tighten the chain the way I've always tightened it. Then I'll always show what I've always shown. What others read on the scale does not concern me."* Being is what matters, not appearances. The number of chain links per section must be the same for everyone involved.

The twin paradox



The twins Nina and Max go on a journey. They both leave at the same time from the same starting point and move constantly under the same influence of gravity during their journey. This means that there are no different effects due to different gravity.

All subsequent actions occur according to their own time.
Neither looks at the other's clock!

Both accelerate for 1 year. After 1 year of acceleration, both have reached 0.9 c. For both, the transition from acceleration to uniform motion is the same.

Nina moves uniformly for 1 year, then she decelerates for 1 year to the turning point and returns in the opposite direction. She rests there for 48 years until her brother arrives. Max moves uniformly for 25 years, then he decelerates for 1 year to the turning point and returns in the opposite direction.

Both have the same accelerations, decelerations, turning point and all related transitions according to their own clock. Nothing is different between the two. The only difference is that Max moves uniformly in a straight line for 48 years longer relative to Nina. According to the principle of relativity, during the 48 years neither of them can tell who is moving and who is at rest. The principle of relativity does not allow for any distinction, because uniform linear motion and rest are the same thing. Nothing in the world can tell the difference.

How old are the two 20-year-old twins when they meet again after a long time?

The following thought experiment is helpful in visualizing the twin paradox: 2 pendulum clocks. You set one up at home and the other on a carousel. When the carousel starts to turn, the pendulum clock changes to a stronger field of force. In this case, due to centrifugal force. The stronger the field of force, the slower the pendulum swings. The clock runs slower accordingly. The same applies to the field of force of acceleration, deceleration or gravity. However, this has nothing to do with the time dilation of the special theory of relativity. This is an effect of the general theory of relativity and does not interfere with the time dilation of the special theory of relativity. If the pendulum clock leaves the stronger field of force, the pendulum swings just as quickly as before. She can't make up for the lost time afterwards. From the timing behavior, you can tell whether a clock has changed its field of force (gravity, acceleration, deceleration, centrifugal force). From the timing behavior, you cannot tell whether a clock is at rest or moving uniformly in a straight line. The principle of relativity does not differentiate between rest and movement. In both cases, the clock runs at the same rate. Clocks at rest and clocks moving in a straight line at the same speed in the same force field run at the same speed. They run at the same rate.

When it was first developed, Hendrik Lorentz related the Lorentz factor to electromagnetism. In order to explain the constant speed of light without ether, it was only later mathematically interpreted into space and time.

Mathematics

There is a real mathematics behind every reality. That is undisputed. No one has ever observed anything else. If there had been a God who created everything, he would have been a mathematician, because every reality is related to mathematics. The reverse is not the case, however. There is not necessarily a reality behind every mathematical result. There is very often a reality behind it, in fact almost always, but not always.

If a farmer harvests 1 ton of potatoes in 1 year, then he will harvest 300 tons of potatoes in 300 years. The mathematics is correct. Any mathematician can confirm that. 1 x 300 = 300 But there is no reality behind it, because no farmer lives for 300 years. If I pour 1 liter of water into a jug, then mathematically speaking I have 1 liter of water in the jug. In reality, however, I only have about 1 liter of water in the jug.

$$1 \times 1 \approx 1$$

Relativistic mass and momentum

The equivalence principle:

Inertial and gravitational mass are equivalent.

At some point, the values of inertial and gravitational mass were related in such a way that they add up to 1:1 here on our planet. In everyday language, this means: 1 kg inertial mass = 1 kg gravitational mass. This is an arbitrary assumption that has proven itself here on our planet. The values could just as well have been set at 1:10. This means: 1 kg inertial mass = 10 kg gravitational mass. The equivalence of inertial and gravitational mass would not have changed.

Suppose I weigh 60 kg here on earth. This means I have 60 kg of inertial mass and 60 kg of gravitational mass. If I were to eat twice my weight, I would have 120 kg of inertial mass and 120 kg of gravitational mass. If I fly to the moon with my 60 kg weight, I will have 10 kg of gravitational mass there due to the reduced gravity and still 60 kg of inertial mass. If I double my weight on the moon by eating, I would have 20 kg of gravitational mass and 120 kg of inert mass. Because 2x10 = 20 and 2x60 = 120. If I fly to the ISS with my 60 kg, I would have 0 kg of gravitational mass and 60 kg of inert mass in zero gravity. If I eat myself up to twice that weight, I would have 0 kg of gravitational mass and 120 kg of inert mass.
Because 2x0 = 0 and 2x60 = 120

The momentum depends on the inertial mass and the speed. The inertia of a mass depends on the number of atoms and their weight. If the number of atoms in a mass does not change and the weight of the atoms does not change because the components of the atoms change, then the inertial mass remains the same throughout the universe. It does not matter whether you move it evenly in a straight line, accelerate it, decelerate it, rotate it in a circle, etc. The inertial mass always remains the same. It never changes. Mass and energy are equivalent. A relativistic increase in mass would also be a relativistic increase in energy. How does a relativistic increase in energy relate to the conservation of energy?

If there is a relativistic, uniform speed in a straight line, then there must also be a relativistic acceleration. Because when a relativistic, uniform motion in a straight line begins to accelerate, then it also accelerates relativistically. Acceleration and gravity are equal. Nothing in the world can distinguish between acceleration and gravity. If there is a relativistic acceleration, then there must also be a relativistic gravity. Because there would only be a relativistic acceleration, but no relativistic gravity, it would make a difference whether an object accelerates or whether it is in the sphere of influence of gravity. Regardless of external measurability. Reality does not depend on whether it is measurable or not. What is relativistic gravity?

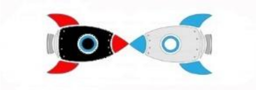
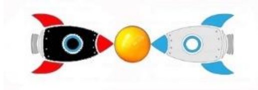
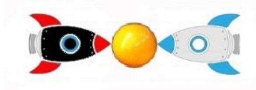
Everything has to do with energy. What is a relativistic energy? How does a relativistic energy relate to the conservation of energy?

Newton and Einstein

Newton and Einstein sit on a Castle park in the forest.

Einstein says to Newton: *" I see a black rocket that weighs 1 g and flies uniformly and straight over my head at **0.9 c** relative to me."*
Newton then says: *" I see a white rocket that weighs 1 g and flies uniformly and straight over my head at **0.9 c** relative to me.. You know, I think they're going to collide over our heads. Should we take cover?"*

Newton and Einstein calculate the momentum that is decisive in the central elastic collision of the rockets in order to know who needs to take cover more. What value do they both calculate for the respective momentum of each rocket?

Variant 2	**Variant 3**	**Variant 4**
 Both rockets are moving towards each other at **0.99 c** relative to Newton and Einstein. With what momentum do the two rockets collide? Does each rocket only feel its own momentum or does each rocket feel its share of the relativistic total momentum of the two rockets relative to each other?	 Before they collide, the two **1 g** rockets hit a **1 g** ball that is at rest relative to Newton and Einstein in the middle of its trajectory. With what momentum do the rockets hit the ball? The ball remains at rest.	 The ball does not weigh **1 g**, but **2 g**. It is twice as heavy as in variant 3. The rockets always hit the ball at the same time (relative to the ball). How do both rockets recognize when they collide whether they are in variant 1, 2 or 3?

Variant 5) In this variant, both rockets have a speed of **0.99 c**

Before they collide, the two 1 g rockets each hit a 2 g ball, which is at rest relative to each other and relative to Newton and Einstein in the middle of its trajectory. Both rockets give part of their momentum to the respective ball. With what momentum do the two 2 g balls collide?

Which value does Newton observe and which value does Einstein observe? All participants are either at rest or moving uniformly in a straight line relative to one another. There is no difference between being at rest and moving uniformly in a straight line. The principle of relativity does not allow for a distinction. - Who needs to take cover more when something crashes above them? Newton or Einstein? There are many perspectives, but only one reality! Behind every reality there is correct mathematics. But the reverse is not true. Behind every correct mathematics there is not necessarily a reality! Which real impulses do both observe? In a collision it is irrelevant whether the impulse was created by a classical or a relativistic speed. Impulse = impulse. The impulse already contains the criteria for its creation.

All clear: Issac and Albert are safe!
In classic central elastic collisions, the original momentum is conserved throughout the entire action. The conservation of momentum applies to both Newton and Einstein.

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