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General Relativity

Introduction

To make my universe model work, I have had to examine the theory of relativity and make some refinements to it, which are presented in this text.

Albert Einstein discovered the general theory of relativity in 1915 AD. The basic idea behind relativity is that the speed of light in a vacuum, approximately 299,792 kilometers per second, is the absolute maximum speed, and nothing in the universe can travel faster than this speed. Relativity also states that any object moving at the speed of light is moving at the speed of light relative to any other object moving at a speed slower than the speed of light. This means that when you are driving a car at, say, 120 kilometers per hour, or just over 3 m/s, and you turn on your headlights, the speed of light shining from the headlights is still, for everyone and everywhere, the same 299,792,000 m/s, and not, for example, 299,792,003 m/s or 299,791,997 m/s. It is reasonable to ask how this is possible?

Figure 1: A crooked mirror distorts proportions.

Figure 2: A gravitational lens imaged with a telescope. The two central yellow lights in the image are actually one.

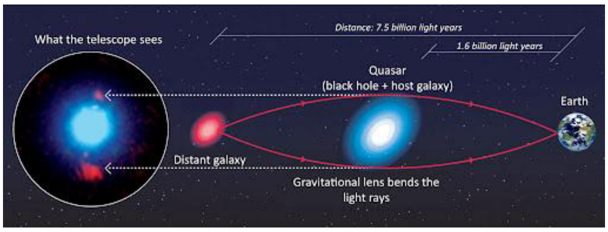


Figure 3: Gravity distorts the geometry of space, causing light, which always travels in a straight line, to change direction. Photons are massless and do not feel gravity, but when the geometry of space bends, photons follow. This phenomenon is called gravitational lensing.

Einstein's spacetime – three-dimensional space and time together, the space in which we live – is a four-dimensional world in which the speed of light is always, for everyone and everywhere constant. To make this possible, distances shorten, masses increase and time slows down locally, i.e. space 'stretches and bends' just like a mirror image in a funhouse mirror. The theory of relativity is divided into special and general relativity. Let's first get acquainted with the special theory of relativity with illustrative examples. The special theory of relativity does not require the speed of light in a vacuum to be exactly 299792000 m/s, which is the real, measured speed of light, but it can be any positive number, so for convenience we will agree that the speed of light is c=100 m/s. To introduce the theory of relativity, I will present an extreme, in reality impossible version of two car drivers. Let us also agree that there is no gravity in the world, in which case space-time will be called Minkowski space, meaning that we will limit ourselves to the special theory of relativity for the time being (we could indeed allow the existence of gravity in this example, because we would reach the same conclusions anyway, but then space-time cannot be called Minkowski space). Let us agree that the speed of the car is 0.5c, or half the speed of light, in this example 50 m/s. We have two cars that are otherwise completely identical, but one is red and the other is blue. Let us visualize the situation so that the red car in Figures 4, 5 and 6 is moving at a speed of 0.5c, or half the speed of light, and the blue car is stationary. In Figure 4, the red car is either overtaking the blue car at a speed of 0.5c, or both cars could equally well be stationary side by side on a two-lane road. The driver of the red car flashes his headlights very quickly, for about 3 nanoseconds, the resulting burst of light is depicted by the yellow ball. If the red car is stationary, the driver immediately accelerates the car to a speed of 0.5c at the same time as flashing his headlights. A kilometer away from the place where the red car flashed its headlights, there is a kilometer post, from which the burst of light is reflected back towards the cars.

Figure 4: A red and blue car are side by side and the red car flashes its headlights and immediately starts driving at a speed of 0.5c if it is stationary.

The burst of light reaches the kilometer post in Figure 5, and when the speed of light is agreed to be 100 m/s,

Figure 5: The red car is halfway to the kilometer post when the burst of light reaches the kilometer post.

$$v = \frac{x}{t} \Leftrightarrow t = \frac{x}{v} = \frac{1000\ m * s}{100\ m} = 10\ s \quad [1]$$

According to formula 1, this happens after 10 seconds, after which the burst of light is reflected back towards the cars. The burst of light therefore reaches the stationary blue car after 20 seconds. This result will probably seem completely reasonable to the reader and even correct if the driver of the blue car is asked about it. The driver of the blue car also agrees with us that the kilometer post is 1000 meters away from him and that the light moved away from him at a speed of 100 m/s.

Figure 6: The red car is 333 meters from the milepost when the reflected burst of light reaches it.

But what does the driver of the red car think about this? Before we ask him anything, we could make the observation that the red car looks shorter in both Figure 4 and Figure 5: from this we know that the red car has been moving the whole time – including when the headlights were flashing – (which is a good thing, since I am not talking about acceleration of the car. The acceleration is gravitation and gravitation does not belong to Minkowski space), because according to the theory of relativity, a moving object shortens in the direction of motion. We also know that, due to the theory of relativity, the driver of the red car agrees with us at least that the burst of light moved away from the driver of the red car at a speed of 100 m/s, despite the fact that the driver himself was moving at a speed of 50 m/s at the same time. Let's take formula 2 from the formulas of the theory of relativity and calculate how much the red car has shortened if its length at rest is 5 meters:

$$x = x'\sqrt{1 - \frac{v^2}{c^2}} = 5\ m\sqrt{1 - \frac{50^2}{100^2}} = 4.33\ m \quad [2]$$

The reader and the driver of the blue car believe that the red car has shortened from 5 meters to 4.33 meters, but the driver of the red car strongly denies this: on the contrary, he claims that the blue car has shortened to 4.33 meters and that in the same proportion the kilometer post is only 866 meters away in the situation in Figure 4! To determine the moment in time when the driver of the red car believes that they are in the situation in Figure 5, another formula from the theory of relativity is applied

$$t' = t\sqrt{1-\frac{v^2}{c^2}} = 10\,\mathrm{s}\sqrt{1-\left(\frac{50\,\frac{\mathrm{m}}{\mathrm{s}}}{100\,\frac{\mathrm{m}}{\mathrm{s}}}\right)^2} = 8.66\,\mathrm{s} \quad [3]$$

and the resulting time 8.66 s after the headlights are turned on, the burst of light reaches the kilometer post. Now the speed of light is the same for everyone:

$$\frac{1000\,\mathrm{m}}{10\,\mathrm{s}} = \frac{866\,\mathrm{m}}{8.66\,\mathrm{s}} = 100\,\frac{\mathrm{m}}{\mathrm{s}} \quad [4]$$

In a situation where the burst of light has moved to the level of the kilometer post (picture 6 and the middle situation in picture 7), the driver of the red car thought that

$$x = 8.66\,\mathrm{s} \times 50\,\frac{\mathrm{m}}{\mathrm{s}} = 433\,\mathrm{m} \quad [5]$$

he was 433 meters from the kilometer post. The arrival of the light burst reflected from the kilometer post back to the eyes of the driver of the red car (Figure 6 and the lowest situation in Figure 7) occurs according to the driver of the red car

$$x = 866\,\mathrm{m} - 433\,\mathrm{m} - 433\,\mathrm{m}\,\frac{50\,\frac{\mathrm{m}}{\mathrm{s}}}{50\,\frac{\mathrm{m}}{\mathrm{s}} + 100\,\frac{\mathrm{m}}{\mathrm{s}}} = 289\,\mathrm{m} \quad [6]$$

289 meters from the kilometer post, but according to the driver of the blue car and the reader of this text, the distance was 333 meters from the kilometer post:

$$x = 1000\,\mathrm{m} - 500\,\mathrm{m} - 500\,\mathrm{m}\,\frac{50\,\frac{\mathrm{m}}{\mathrm{s}}}{50\,\frac{\mathrm{m}}{\mathrm{s}} + 100\,\frac{\mathrm{m}}{\mathrm{s}}} = 333\,\mathrm{m} \quad [7]$$

Both the drivers of the blue and red cars are right (according to the generally accepted relativity interpretation, but later in this text we learn that the driver of the red car is lying about what he sees): because of relativity, they simply perceive the world differently. Whereas in Figures 4, 5 and 6 the world was viewed as seen by the driver of the blue car and the reader, we could move into the red car and then the situations in Figures 4, 5 and 6 would look like Figure 7:

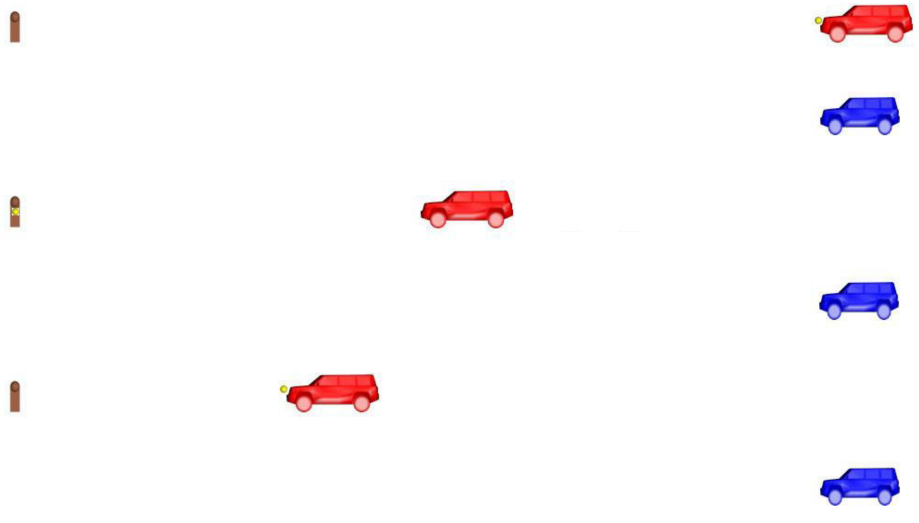


Figure 7: the situations in pictures 4-6 according to the view of the driver of the red car, but he is not telling the truth...

Hey, common sense, where are you?

Based on what has been written above, the theory of relativity probably makes no sense to the reader: the course of events is completely strange compared to everyday life. How can the same object be in different places and at different times at the same time, as in the previous example, cars, a burst of light and a kilometer post were? The scientific community does not know how such a cosmic farce is possible, but nevertheless the theory of relativity works in everyone's everyday life all the time. The fact that the things described above are not observed in everyday life is due to the fact that the speeds of objects in the space in which we live are so small compared to the speed of light. Even the speeds of celestial bodies do not reach anywhere near the speeds at which relativity phenomena become observable. However, this does not eliminate the fact that the relativity behavior of space in the way described above is still very strange and contradictory.

I will now turn to speak about (elementary) *particles* instead of objects like cars, since all objects are made up of particles. Many of the known elementary particles are very short-lived, so the reader should assume that the word 'particle' in this text refers to protons, neutrons, and electrons, which are the particles that make up atoms and which are particles with mass. I will also talk about a massless elementary particle called a photon, which represents electromagnetic radiation.

According to the theory of special relativity, every moving particle with mass in space has an infinite number of different positions, depending on which other particle its position is measured in relation to. But what if the massive particle is absolutely stationary? Asking such a question is considered blasphemous by physicists, because Einstein's theory of relativity assumes that absolute position does not exist or at least cannot be determined: only relative position, i.e. position relative to something else, can be determined. But in order to find an explanation for how the theory of relativity is possible, we have to invent something new and question the old. The theory of relativity itself does not deny the existence of absolute position, it is merely an assumption. What if the red moving car mentioned above happened to be absolutely stationary in space, then what? There's no way to know that (actually, you can in theory, but we'll get to that later) and it doesn't have to have any observable effect on space or on the theory of relativity.

The theory of relativity means that the 'same' time and place are not the same for two observers moving at different speeds. I will now give my own explanation of the theory of relativity's relative time and relative position, and this explanation removes the contradiction between the drivers of the blue and red cars so that Figure 7 and the observations of the driver of the red car do not correspond to reality, but Figures 4-6 and the observations of the driver of the blue car do – or vice versa, depending on which of the cars is *absolutely* stationary in space. I will deal separately with the contradictions caused by *relative time* and *relative position*, since each has its own, independent solution. This text assumes that the blue car is absolutely stationary in space (of course, in reality, no car is absolutely stationary in space, even if it is parked, because the Earth is in constant motion! But it is worth noting that all objects in space move at cosmic speeds – well below 1,000,000 m/s, or 1,000 km/s – and relativity phenomena are not relevant in such slow motion. Furthermore, when objects move approximately the same speed and in approximately the same direction, they see each other in exactly the same way and their time progresses at the same speed, even if their *absolute* speeds are significant from the perspective of relativity).

Relative and Absolute Time

I would like to start by warning the reader that I am now presenting impossible paradoxes related to Einstein's theory of relativity. I would also like to point out that the problems can be solved in a simple way, which I will also present.

The fact that an event starts simultaneously from the same starting point – which is observed both in from stationary and moving observation point – and ends in terms of stationary position, for example, after 10 seconds, but in terms of motion, the duration of the same event is, for example, 8.66 seconds, requires an extension of the time dimension from the present to the past: the matter associated with the event, for example, the red car in the previous example, must have a time dimension of at least 1.34 seconds. The matter of space consists of massive elementary particles and an individual particle must exist in the same state and position both after 8.66 seconds and after 10 seconds. And more, regardless of that, even if the particle, for example, moves or changes into another particle. And if a particle has been born at some point and later, for example, changes into another particle or otherwise ceases to exist, the particle must have a certain lifetime for an infinte number of different time frames, and therefore its time dimension must also be defined somehow.

According to the formulas of the theory of relativity , the passage of time for a massive particle of formula 9 does not slow down if the particle remains stationary. In this case, the particle's time passes maximally quickly. On the other hand, if the particle moves at a speed slower than the speed of light, the passage of time for the particle is maximally slower. And if a massive particle moves at the speed of light, its passage of time stops completely. The time dimension s of a particle is therefore the difference between the absolute time t_0 and the particle's own time t, which is defined for an infinitesimal distance by the Lorentz world metric, or formula 8:

$$ds^2 = c^2\,dt_0^2 - dx^2 - dy^2 - dz^2 \qquad [8]$$

$$t = \frac{t_0}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad [9]$$

The two limit values thus obtained, $t_0 - t = s$, delimit the particle's dimension s on the time axis, if we substitute its absolute velocity into formula 9 as the particle's velocity: when a massive particle is born into spacetime, its time dimension comprises only the moment of birth, but after that the time dimension progresses along the time axis at the front end with the *absolute present moment*, advancing at maximum speed, and at the same time stretching at its rear end in the pace of the slower relative passage of time to encompass a longer period of time, so that for a long-lived and high-velocity particle the time dimension may be millennia long or even longer after billions of years. The moment of birth is the particle's present moment, after that the present moment is the particle's rear end. The above-mentioned *absolute present moment* does not actually represent any kind of present, because it cannot be defined from space-time, meaning we cannot measure it, but it is necessary in a way we will see soon.

In contrast, with massless particles such as photons, which travel at the speed of light, the time dimension only encompasses the absolute present. The present of a photon progresses with absolute time, i.e. time passes at the fastest possible rate; the difference is radical compared to massive particles, whose own time does not progress at all if they travel at the speed of light! However, it is worth noting that a massive particle cannot be accelerated to the speed of light, because according to the theory of relativity, this would require an infinite amount of energy.

All this raises new questions: If the time dimension of a massive particle is, say, ten years (the particle could be part of a spacecraft that traveled almost the speed of light in space on a circumnavigation, so that when it returned, the ship's clock was five years behind the clock on its home planet. The particle already had another five years before the space trip), and the particle absorbs a photon at the front of its time dimension, then how can the particle's present moment, or the back end of the time dimension, know anything about this? It can't know it until the information about the absorption has moved from the middle to the back end, which takes five years! And what happens when the particle emits a photon? This is a more complicated situation: the information about the emission first moves from the particle's present moment, or the back end, to the absolute present moment, which takes its time, and only then does the photon escape into spacetime.

The previous one might have raised more questions. If the transfer of a photon from the lamp to the viewer's eye requires, say, eight years of time travel into the future in the particle emitting the photon, then a transfer from the lamp to the viewer's eye, and finally a five-year time travel into the past in the viewer's eye, are all those years added to the photon's travel time? If photons travel in the future, how can we even perceive them, and when our relative present reaches the future, isn't the present already defined by the photons in the future? At this point, the reader is probably throwing up his hands and saying that this makes no sense, and I completely agree with him or her!

So let's discard the time dimensions of particles, because they are just abstractions I invented to illustrate Einstein's theory of relativity in a way that just doesn't make sense. Instead, let's solve the problem by stating the same thing that Einstein himself stated in his time: *time for each massive particle runs at its own pace*. A bit like in the old days, when clocks were mechanical wind-up clocks, each clock ran at its own pace! But what Einstein didn't say, and what the scientific community hasn't yet stated as I write this, is that in order for time to run at its own pace for each particle individually, and for all these times to proceed individually at the speeds required by Einstein's theory of relativity, an *external pacesetter* is needed to adjust the time flow of each particle to the right pace. The external pacesetter must have its own concept of time and space independent of the theory of relativity, and I call these *absolute time and position*. Furthermore, the external pacesetter itself is a prisoner of the passage of time, just as nothing in spacetime can return to the past or move 'ahead of time' into the future: everything has its own present, and for the external pacesetter this is the *absolute present moment*. However, this text will not discuss the external pacesetter any further, but you can learn more about it here.

It is important to understand that all physics and chemistry occur in terms of *relative time*. We can only measure relative time, and all our observations of our environment occur in terms of relative time. A quartz crystal vibrates in terms of relative time. We age in terms of relative time. However, *absolute time* is not needed for anything other than determining absolute position, and this determination cannot be made from spacetime.

Relative and Absolute Position

In the car example above, the driver of the blue car claimed that the red car had shortened in length, and the driver of the red car claimed that the blue car had shortened. Shortening, or shortening in length, means a change in position, either at the front, the back, or both. To accomplish this would require spacetime to do one of the following:

- The first option is that electromagnetic radiation, or photons, is invariant and matter must 'multiply' itself to give itself the correct proportions separately to all points of view for all possible speeds.
- Another option is that matter is invariant and electromagnetic radiation, or photons, know what is expected of them at any given time, and they change their course accordingly so that at all points of observation, an image obtained is distorted in just the right way.

This text does not, of course, support either of the previous options, but it is clear that the same matter cannot appear in two or more different places at the same time! So I assume that every particle in spacetime has an *absolute position*: then it is possible that the driver of the red car did not see the blue car shortened, but was himself shortened – I can solve this problem this elegantly, because humanity has never had a spacecraft or any other device that would move at relativistic speeds, so that the passengers could tell what the environment looks like at relativistic speeds. Only the driver of the blue car saw the red car shortened according to pictures 4-6, because the red car was absolutely shortened! Therefore, I can declare the content of picture 7 to be untrue. If absolute position is true, it is possible to know which of the two bodies is moving at the greater speed within the absolute time described above, and then it is possible that only the faster moving body shortens more in its direction of motion than the slower moving one (of course, all moving bodies shorten in their direction of motion according to their speeds).

If absolute position did not exist, there would also be no absolute velocity, and a particle could not be absolutely still, and then it would be impossible to limit the time dimension of a massive particle to the absolute present moment. In that case, it would not be possible to develop a theory of how 'matter in different times' interact with each other, i.e. how relativity works. Thus, relative position does not actually exist anywhere other than in a person's own observations of their environment and, of course, in Einstein's theory of relativity. Absolute position may never be measured by a person, although I believe it exists. On the other hand, absolute stationarity can be measured if the necessary technology could be built. But unlike relative time, defining relative position as absolute changes the behavior of observable reality to something different from what Einstein himself thought in Einstein's theory of relativity. Relativity was developed to implement CPT symmetry, and therefore in the car example above, both

The letter combination CPT comes from the English words Charge, Parity and Time. They represent three symmetry rules, C-symmetry, P-symmetry and T-symmetry. In C-symmetry, particles and antiparticles follow the same laws of nature, in P-symmetry, the laws of nature do not change in a mirror image situation and in T-symmetry, the system returns to its previous states. CPT symmetry means that all of the above symmetries are combined into one.

drivers of the car were supposed to see the other car as shortened in the direction of motion. But the idea of absolute position – and thus one car shortening more and the other shortening less or not at all – breaks CPT symmetry, and that's fine. We saw from Figures 4-6 and 7 that they contradict each other and the only way to remove that contradiction is to abandon CPT symmetry. CPT symmetry is a human-developed construct of thought, not an observation. Humanity has never driven a car or any other device at relativistic speed, so humanity does not know what kind of world the driver of the red car would see. But what did the driver of the red car possibly see? We could think that he would see the blue car stretched out, because he himself had shrunk, but since the kilometer post must be 866 meters away anyway, the image cannot be formed. The driver of the red car was probably unable to see anything that was not traveling with his eyes in approximately the same direction and at the same speed: that is, he saw nothing but noise, the snowfall of old CRT televisions.

Instead, it is known indirectly from the results of particle accelerator experiments that the driver of the blue car sees the red car as shortened in the direction of its motion. Of course, this is assuming that the blue car is absolutely stationary, or moving at a cosmic speed of at most, say at most 1000 km/s, which compared to the relativistic speed of at least 45000 km/s is as if it were stationary. It is important to note that although absolute and relative time actually exist according to this text, relative position does not exist: particles only have an absolute position, which we cannot determine.

I have now made two changes to Einstein's theory of relativity, namely adding absolute time and absolute position. But it should be noted that these changes do not affect the mathematics of special relativity in any way - the original equations of Einstein's special relativity are valid and work exactly as Einstein originally intended them. Similarly, the above formulas 1-9 are all still valid. And even though relative position does not exist, we still do all calculations with relative time and position values, because we have nothing else available; provided that the basic coordinate system, which is perceived as 'stationary' in the calculations, is actually moving at a cosmological speed in space, relative time and position values give 'sufficiently correct' results.

General Relativity

Everything written above was related to the special theory of relativity, which only deals with time and position. But there is a third element in relativity that must be taken into account: mass. In this case, we are talking about the general theory of relativity. According to the general theory of relativity, the mass of an object increases as the speed of the object increases, time slows down as the speed increases, and length shortens as the speed increases. For example, in the car example above, if the rest mass of the red car is 2000 kilograms, its mass at a speed of c/2 would be

$$m = \frac{m_0}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{2000\ \text{kg}}{\sqrt{1 - \frac{50^2}{100^2}}} = 2309\ \text{kg} \qquad [10]$$

2309 kilograms. A clear increase in mass, but not so great that it would have any bearing on the conclusions drawn in the text above. I wrote earlier that it would be possible to determine whether an object in space is absolutely stationary. This is achieved by moving the measuring object freely in three dimensions on a very precise scale that is stationary (it does not have to be absolutely stationary). When the direction and speed at which the mass of the measuring object is smallest is found, the absolutely stationary position has been found. Naturally, the accuracy of the scale must be so high that it is unlikely that such a thing can ever be built, let alone a device that can controlably move the measuring object at the necessary cosmic speeds.

General relativity and the inclusion of mass change the situation in relation to special relativity in such a way that the geometry of space is no longer unchanging, but is in a constant state of change all the time: mass in space causes spacetime to bend. Thus, even massless particles, such as photons of electromagnetic radiation, change their direction under the influence of gravity by traveling along the straightest path, the geode, as exemplified by the gravitational lens in Figure 2.

But general relativity changes the concept of a straight line even in completely empty, massless space: it requires that spacetime is a curved, closed spherical surface. Let's get to know general relativity through Einstein's equation:

$$G_{ab} = \kappa T_{ab} \Leftrightarrow G_{ab} = -\frac{8\pi f}{c^4} T_{ab}, \quad \kappa = -\frac{8\pi f}{c^4} \qquad [11]$$

Equation 11 contains the general theory of relativity in its entirety. In the equation, G_{ab} is the Einstein tensor, T_{ab} is the energy-momentum tensor, c is the speed of light, 8π is the solid angle in spacetime, and f is the gravitational constant, which has a value of 6.67259*10-11 Nm2/kg2. The energy-momentum tensor T_{ab} is a 4x4 matrix that describes the properties of matter in spacetime in terms of the energy density ρ, the momentum density I, and the (surface) pressure P:

$$T_{ab} = \begin{pmatrix} P_{xx} & P_{xy} & P_{xz} & cI_x \\ P_{yx} & P_{yy} & P_{yz} & cI_y \\ P_{zx} & P_{zy} & P_{zz} & cI_z \\ cI_x & cI_y & cI_z & c^2\rho_t \end{pmatrix} \qquad [12]$$

The reader might ask that since the general theory of relativity is intended to include gravitation in relativity, wouldn't it be important to find out how mass is distributed in space? That is precisely the purpose of the energy-momentum tensor 12. But, since calculation 10 showed us that the magnitude of mass depends on the speed at which mass moves in space, we cannot use mass or density as a criterion for the distribution of matter in space. We need some quantity whose amount remains constant in space and which specifically describes the occurrence of matter: Einstein defined momentum as such, i.e. the product of mass and velocity. Unfortunately, the matter is not quite that simple, because the speed of light as a speed maximum limits the use of classical momentum, i.e. the product of mass and velocity, so the momentum p must be redefined for the theory of relativity according to formula 13:

$$p' = \frac{m_0 v}{\sqrt{1 - \frac{v^2}{c^2}}} \qquad [13]$$

The energy-impulse tensor 12 is usually used to determine the strength properties of an inhomogeneous material, for example rock, soil or a wooden object. In this case, the tensor would be just a 3x3 matrix, since the time dimension is not needed in the case of a static body and it would be called the stress tensor. But the tensor 12 is part of Einstein's equation and is intended to describe the matter in all of space, i.e. celestial bodies and space dust, solar systems and galaxies, which I assume are distributed more or less evenly, homogeneously and isotropically throughout spacetime, so the tensor needs information about the impulse and energy density in addition to pressure. This text will not explain how to obtain the necessary valuesfor the tensor 12. How else can there be pressure in space at all, when it is mostly empty space? Well, there is no true pressure, and the symbols P_{ab} of the tensor 12 do not represent pressure, but the flow of momentum. Then why am I talking about pressure at all? Because Einstein originally applied the theory of classical continuum mechanics to his general theory of relativity, and the idea of "pressure" is rooted in that.

Instead, the Einstein tensor G_{ab} on the left side of equation 11 is more interesting than the one on the right, because it determines, among other things, the geometry of space. But what exactly does equation 11 solve if the left tensor determines the geometry of space and the right tensor determines the distribution of matter in space? Naturally, we would like to find out the gravitational field of space so that we could calculate, for example, the exact trajectory of the planet Mercury (the Newtonian mechanics of classical physics can calculate the orbit of Mercury almost correctly, but the calculated perihelion precession deviates slightly from the observed value. This small deviation is explained by the general theory of relativity). This requires two things: the geometry of space, which in the case of Mercury's trajectory means the gravitational field of the Sun, and the distribution of matter in space, which includes the masses of Mercury and other necessary celestial bodies – at least the largest planets orbiting the Sun. Determining an arbitrary gravitational field, i.e. the general solution of equation (11), is not possible, and in practice we have to settle for quite simple arrangements. Let us write equation 11 in such a form that there is also a separate tensor for the gravitational field in the equation:

$$G_{ab} + \Lambda g_{ab} = -\frac{8\pi f}{c^4} T_{ab} \Leftrightarrow R_{ab} - \frac{1}{2} R g_{ab} + \Lambda g_{ab} = -\frac{8\pi f}{c^4} T_{ab} \qquad [14]$$

In equation 14 g_{ab} is the so-called metric tensor, which determines the geometry of spacetime. The term Λ_{gab} also needs a metric tensor, but it is not part of the Einstein tensor. Therefore, only a term dependent on the metric tensor g_{ab} can be added to equation 11, as is done in equation 14, without affecting the law of conservation of energy. The other variables in equation 14 are the Ricci tensor R_{ab} and the Ricci scalar R, as well as the cosmological constant Λ, which Einstein added to the equation to make space stable, i.e. so that space would neither grow nor shrink. The gravitation of matter affects the geometry of space by curving it, as can be seen from the gravitational lens in figure 2, but this effect is not yet included in the metric tensor g_{ab}, but the Ricci tensor is needed for it. The Ricci tensor determines the curvature of space, as will be explained in more detail here.

Within the framework of relativity, it is therefore not possible to use mass as a measure of the amount of matter, because mass changes with velocity. This does not mean, of course, that matter, i.e. electrons, protons or neutrons, is lost or created: the mass of the particles in question only depends on their velocity. Therefore, matter must be measured by other methods, and the rate of flow of momentum through each point in spacetime is suitable for this purpose.

Metrics of General Relativity

Let us now turn our attention to the cosmological constant Λ. As mentioned, Einstein added a term containing the cosmological constant Λ to equation (14) to make space stable, but since then that term has mostly been removed from the equation. When the Big Bang theory of the universe was invented, space did not need to be stable, but expanding space is a natural consequence of the Big Bang and the cosmological constant was allowed to go.

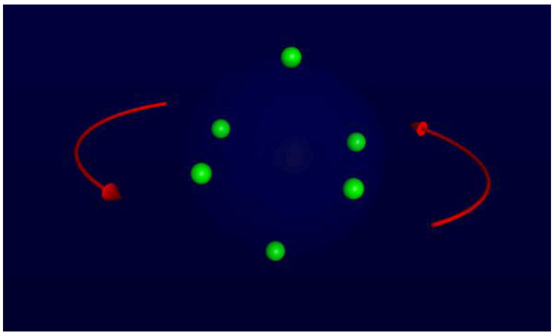
Furthermore, as the Friedmann Robertson Walker models became established to describe spacetime, the metric of general relativity was changed from the metric originally proposed by Einstein. Einstein's metric is given in equation 15,

$$ds^2 = g_{ab}\, dx^a\, dx^b \qquad [15]$$

but the Friedmann Robertson Walker metric chosen instead of the Einstein metric is represented by formula 16:

$$ds^2 = dt^2 - R^2(t)\, g_{ab}\, dx^a\, dx^b \qquad [16]$$

This text follows formula 15, the metric originally presented by Einstein. This collection of texts also disputes the existence of the Big Bang. However, it is good to illustrate the difference in the metrics of formulas 15 and 16 in practice: namely they describe completely different worlds. Figure 8 shows the spacetime according to formula 15 and figure 9 shows the spacetime according to formula 16:



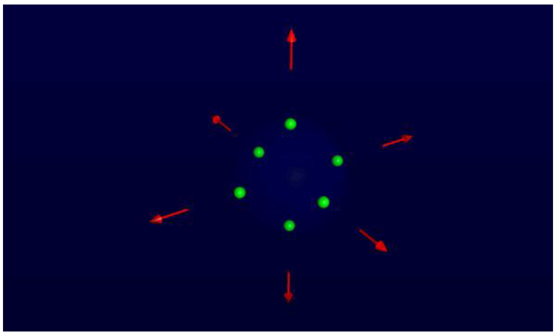


Figure 8: In Einstein's original metric, the three spatial dimensions and one time dimension of space are placed on the four-dimensional surface of a five-dimensional blue sphere. In the figure, the green spheres represent celestial bodies and other matter on the surface of the sphere, i.e. in space. The spheres rotate counterclockwise in the direction indicated by the red arrows, because that direction is depicted as the direction of time in the figure.

Figure 9: In the Friedmann Robertson Walker metric, the three spatial dimensions of space are placed on the three-dimensional surface of a blue four-dimensional sphere. The time dimension is parallel to the radius of the sphere, and therefore the green spheres representing celestial bodies and other matter move away from each other in the direction indicated by the arrows, away from the Big Bang at the center of the sphere. Thus, the theory of relativity can be used as a 'proof' for the theory of the expansion of the universe, but it is only a matter of choosing a metric.

Figure 9 clearly shows that the Friedmann Robertson Walker metric actually requires an expanding space for time to flow. In contrast, Einstein's original metric in Figure 8 does not require space to expand or contract, but it does, unless the cosmological constant Λ is used to correct the problem. But what exactly does the term Λgab represent in equation 14? Its unit must be the same as the other terms in the equation, energy density. If Λ is negative, it tends to shrink space. When Λ is positive, it causes space to expand. In other words, when negative, the cosmological constant reduces the gravitational field of space, and when positive, it strengthens it evenly throughout spacetime. It is also possible that the cosmological constant Λ is not a constant, but a variable quantity, although Einstein thought it was a constant.

Summary

The above text on Einstein's theory of relativity aims to present the theory of relativity as Einstein intended it, with the exception of the following clarifications:

- Relativity does not mean that there is no absolute position or time in space.
- Lorentz contraction is not symmetrical: only the faster moving object A shortens absolutely in the direction of motion, the slower moving object B shortens less or even a stationary B does not change its absolute dimensions.
- The material has absolute rest mass.
- The Friedmann Robertson Walker metric or something similar does not belong to the theory of relativity, but the metric must be the metric originally proposed by Einstein.
- CPT symmetry does not exist.

Space is not expanding but stable and can potentially be adjusted to the desired size using the cosmological variable Λ. Who would make this adjustment can be read about here. These refinements are necessary to make a 7-dimensional universe model possible.