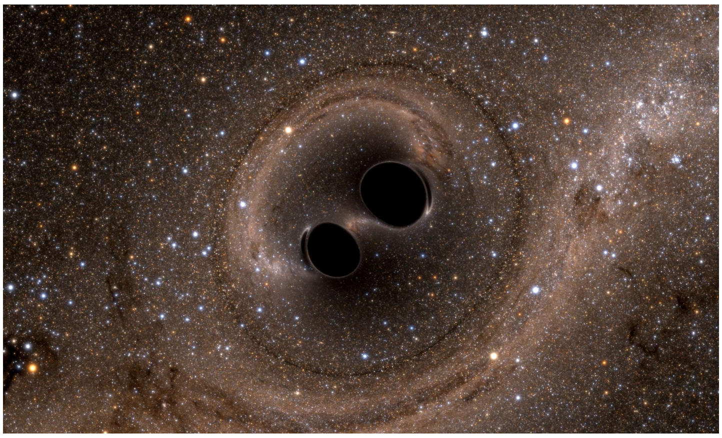

DIMENSIONAL PHYSICS

A theory in which EVERYTHING consists of spacetime

EXPOSEE

New approach to a theory of everything in which quantum field theory is derived from general relativity. Every mass-energy equivalent corresponds to a mapping in space-time, a space-time density. A mapping of the space-time density over a low-dimensional transition generates the entire quantum field theory. Black holes are given a much greater role and dark energy is no longer needed because space-time itself represents a potential field.

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Preface

Dimensional Physics (DP) is a theory that represents everything in the geometry of spacetime – not just the curvature of spacetime. The aim of DP was to unify General Relativity (GR) with Quantum Mechanics (QM). This goal was partly achieved and partly missed. The result was a “theory of everything.”

GR and QM are given a common basis through their geometric representation in different spacetimes. Nevertheless, the two theories describe different phenomena. A unified mathematical description of both theories is therefore not possible. This problem arises from the fundamental approach of DP to represent gravity and its cause – energy and mass – completely geometrically in our spacetime.

DP leads to a paradigm shift in the consideration of spacetime. Will it trigger a revolution in physics? That remains unclear. What is crucial is that DP offers new approaches to solutions. It opens up a new space for solutions and creates new starting points for the discussion of physical fundamentals.

We often simply ask the question: Why? We do this until it is clear why a formula or a natural constant in the mathematical description looks exactly as it is currently used. As a result, we question some objects of physical descriptions that physicists hardly think about after their first semester. These include, in particular, the dimensions of space and time, which form the basis of the theory. Hence the name: Dimensional Physics.

The present description of DP is divided into three parts:

- Part 1: A brief introduction to the basic idea behind DP
- Part 2: The fundamentals of DP with the principle of relativity, gravitation, and cosmology
- Part 3: QM as a consequence of GR. We will almost use QM and not quantum field theory (QFT) for explanations. QM is easier to understand than QFT in the explanations. However, QFT is the more appropriate description for DP.

As you can see, abbreviations are introduced in the text. There is a separate list of abbreviations. When counting the dimensions in a spacetime, only the spatial dimensions are counted, deviating from the standard. The reason for this will become clear from the theory. This text is not a strictly scientific description. In order to make DP accessible to a wide readership, a relaxed tone is explicitly chosen. Mathematics is used where it makes sense. However, it is not possible to do without it.

Then I hope you enjoy exploring and thinking.

Let's start our journey to a theory in which EVERYTHING consists of spacetime.

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1 Introduction

1.1 Some simple fundamental questions

In DP, we want to achieve one of the most difficult things that can be attempted in physics. No, not unifying GR and QFT. That was just a starting point. The DP is so well developed that it is clear what we need to do given the current state of physics. We need to rethink some of the fundamentals of physics. Getting someone to do that is incredibly difficult. This is not only true in physics. Once something has been understood and thus dismissed as simple, no one wants to engage in a deeper discussion about it. This is exactly what we will have to do here.

The degree of difficulty is increased once again because the DP does not provide a new "highly scientific" mathematical model. Everything we need is already there. We want to achieve a new description of physics using well-known mathematical models. That sounds more like One Thousand and One Nights than a physical theory. We will look at the old descriptions given with a new perspective. It's like a puzzle where you already know the names of all the individual pieces but still can't solve it. You get partial pictures, but not the whole picture. This continues until the redeeming idea comes along. It's not a 2D puzzle, but a 3D one, and everything fits together. With DP, we will need a little more. We will use spacetimes from 4D to 1D (note: in DP, only the spatial dimensions are counted) in different constellations. This will enable us to solve the physics puzzle.

The new logical connections in DP are so extensive that we can fully answer the following questions:

- Questions about c, h, and G
  - Where do the important natural constants c, h, and G come from?
  - Why can they be converted into each other using Planck units?
  - Why is there a maximum speed at all with c?
  - Where does h, the "clock for quantization," come from?
  - We will see that G is not a natural constant.
- Questions about GR:
  - Is there a singularity in a black hole or in the Big Bang?
  - Where does the principle of relativity come from?
  - Where does the equivalence principle come from?
  - Why can't the mathematical description of GR be linear?
- Question about QM:
  - Why **can't** QM be unified with GR?
  - Why can QM be unified with special relativity theory (SR)?
  - Why do probabilities exist?
  - Why is there quantization?
  - What is entanglement?

Stop! A list of questions like this could go on forever. We can see that these questions concern the foundations of physics. The starting point was a unification of GR and QM. Today, in 2026, we are certain that these two theories, with their current mathematical description, are fundamentally incompatible. It should therefore come as no surprise that the DP deals precisely with these fundamental considerations. If we do not need a new mathematical description and want to create a common basis, then there must be something wrong with the current foundations. This is where we come in.

1.2 Starting point: GR or QM

The starting point was the idea of unification. Unification means bringing different things into one identity. The goal was to achieve this with as few different objects as possible. Taken to the extreme, this idea means having a single object for everything. Then there can be no more differences. Where do we start in this search? Here we have two different approaches to choose from:

- We try to expand on known theories
- We build a completely new theory

Approaching a completely new theory was not the focus. The desired goal was the unification of GR and QM. It is easier to start with the known descriptions. Since GR and QM are the pillars of modern physics, we choose one of them.

Almost everyone looking for unification starts with QM. For most physicists, this approach has almost religious connotations. Their motto is: once we have quantized everything, we will have found the Holy Grail of physics. In fact, this approach makes sense. QM is the best-confirmed theory we have. In addition, QM describes all elementary particles and the interaction between them. Only one interaction is missing: gravity. We are certain that all statements about QM, such as probability, uncertainty, entanglement, linear mapping, etc., are 100% correct. We are equally certain that GR does not contain any of this. In addition, GR still contains such unsightly things as singularities. Hence the assumption that GR is not consistent.

Many brilliant minds have long sought a unification based on QM. The result has always been the same. The mathematical tools have been improved and knowledge has been generated. However, we have not come any closer to the actual solution. Therefore, as unlikely as it may sound, we choose GR as our starting point. What's more, almost everyone who studies physics in depth develops a personal preference for one of the two theories. For me, this was GR. This adds another property to the "single object for everything" we are looking for. The image on this object should be geometrically describable. GR is a geometric approach.

1.3 Basic idea of DP (approach)

We have a rough idea of what we want to achieve and a starting point. Let's take a closer look at GR. To do this, we will consider Einstein's field equations. We will use the simplest form:

$$\boldsymbol{G_{\mu\nu} = k * T_{\mu\nu}}$$

Oh, the first formula, don't panic. We don't need to be able to solve this equation. It's about the structure and the objects used. On the left side is the Einstein tensor $G_{\mu\nu}$. This describes the curvature of spacetime. On the other side is k as a proportionality constant. We will come back to this in a later chapter. Then comes $T_{\mu\nu}$, the stress-energy tensor. If we look at this equation with our goal in mind (an object, geometric representation), then we have already completed the first half.

What was Einstein's ingenious idea? To no longer conceive of gravity as a force, but to map it directly geometrically onto a single object, spacetime itself. For us, this means developing this idea further and transferring it to the other side of the equation. We have to find a geometric mapping in spacetime for the stress-energy tensor.

This means that the field equations on both sides describe a "deformation" of spacetime. One deformation is known as spacetime curvature. We will refer to the counterpart or source of spacetime curvature as spacetime density. This gives us our approach. We have a single object in the equation, spacetime. The equation describes purely geometrically a change in spacetime for the respective "deformation." This does not change the calculations within GR. The equation remains as it is. We change our view of GR. The approach can thus be summarized very simply:

Everything consists of spacetime

We will obtain different and also infinite spacetime configurations in order to be able to map QM, but really all descriptions of nature are geometric mappings in a spacetime. Currently, there is a mnemonic for GR. It goes something like this: "Matter tells spacetime how it must curve, and curved spacetime tells matter how it must move." Here, a clear separation between the stage (spacetime) and the actor (matter) can still be seen. A paradigm shift must take place. The new appropriate saying is:

Spacetime is not only a dynamic stage, it is also the only actor

1.4 Spacetime structure and predictions

The approach that any mass-energy equivalent is a spacetime density and thus a direct representation in spacetime will lead us to the most important conclusion in DP. Spacetime has boundaries. Not given by length or volume, but in its structure. Through SR, we will recognize that spacetime can lose a spatial dimension and the time dimension. Length contraction and time dilation to zero. The mapping of spacetime density across this spacetime boundary will necessarily generate all the elements we need for QM and explain the structure of GR:

- The spacetime boundary, to lower-dimensional spacetimes, is the reason why QM exists and cannot be directly combined with GR. Our spacetime alone does not provide the necessary structures for QM to be generated. These additional structures will be provided by the lower-dimensional spacetimes.
- The time dimension is not identical across different spacetimes. Each spacetimes has its own time dimension.
- Each spacetime configuration has unique Planck values. We cannot calculate with identical Planck values in different spacetime configurations.
- In calculations, it is no longer permissible to simply add or remove a spatial dimension for a higher- or lower-dimensional spacetime. These are different objects with different Planck values and separate time dimensions. Therefore, the spacetime boundary is the reason why many new theories (e.g., string theory) do not work from the perspective of DP.
- The higher-dimensional boundary (one extra spatial dimension but no extra time dimension) is given by the condition for a black hole. The lower-dimensional boundary is given by the speed of light. This implies that the gravitational constant G is a composite value derived from these boundary conditions.
- Purely from the logic of DP, SR is closer to QM than GR. Therefore, SR can be unified with QM, but GR cannot be unified with QM.
- The rest mass of an elementary particle is, with the value recognizable to us, the Planck mass in the spacetime configuration responsible for the respective particle.
- There are three generations of fermions, as these must be mapped onto the three spatial dimensions in our spacetime. There are three low-dimensional interactions, as we can only exchange three different geometries between the particles. The number 3 in the classification of particles, or 1/3 in the case of charges, depends on the number of our spatial dimensions.
- The possible low-dimensional geometries are exhausted by the Standard Model of particle physics. There can be no further new particles. Not even for dark matter.
- Here is a somewhat "wilder" statement: The Higgs field is almost identical to our spacetime. Without gravity, our spacetime itself is a scalar potential field.

Here, too, just stop! The list could be expanded by several points. However, we can already see from these few points that, in the new view of the dimensions of space and time, we must make a fundamental change in how we deal with these objects. There is a paradigm shift, but without new mathematics. We explain why the given mathematics must look exactly as it does. This is particularly important for QM.

The points listed are all a confirmation of GR and QM. There are no deviations in the observations. However, we can make experimentally testable predictions. For example, the last statement, that spacetime is a scalar potential field, results in observable changes for cosmology. The early universe must be different in some ways from our present universe. The latest observations from JWST can be explained very well with this.

- Many more black holes must be discovered in the early universe than should be possible according to the standard model of cosmology.
- These black holes must be larger than is possible according to current calculations. GR does not change, but we still obtain a higher Eddington limit. Spacetime as a potential field changes the valence of objects, e.g., momentum (which is also just a spacetime density). Momentum as such is generated identically in the early and present universe during a process. However, its valence in the respective development of spacetime is different (potential field).
- Spacetime expansion is an intrinsic property of our spacetime. Even without an object, spacetime itself is already a form of energy and thus causes spacetime expansion.

This list could also be extended. However, the topics are dealt with in detail in the text.

1.5 Mathematics and requirements for the reader

As you can see from the introductory text, more text than formulas are used. This will remain the case. Formulas will be used in their simplest form when necessary. However, this is absolutely essential. A description without mathematics is not possible. To ensure that this text remains accessible to a wide readership, we aim to use a simple level of mathematics. This means that we are not doing mathematics here, but rather what we might call "a little bit of formula pushing." We do not need to be able to derive or solve formulas such as the field equations mathematically. However, the structure behind them must be explained. The goal is to always know the reason behind all natural constants and formulas. A separate small section will be added shortly.

Not every detail from the physics textbook will be explained from scratch. Readers should be interested in physics and be able to identify the formula used in the introduction. For physics professionals, it may therefore seem "long-winded/philosophical." The decision to describe the DP in this way was made explicitly with this in mind.

The chapters must be read in the given order. Since the mathematics and designation of objects do not change, one has a certain idea about this. However, we will assign a different meaning to some objects, e.g., the speed of light. This means that a different meaning cannot be avoided for the same name. Therefore, the order of the chapters must be followed when reading.

1.6 The why is currently more important than the how

It is often assumed that physicists always want to clarify the "why" behind a phenomenon. In fact, universities often focus solely on the "how," i.e., the calculation, as the most important aspect. This is closely related to quantum mechanics, which is said to be the basis of everything. Without DP, this cannot be explained in a purely logical way. It only works with mathematics. With a lot of complicated mathematics. At the forefront of research into QM or string theory, the fields of work of a physicist and a mathematician are no longer distinguishable. This is exactly where we come in with DP and want to change this. Even QM must be understandable from a logical point of view.

In my opinion, a change in the approach of physicists occurred about 150 years ago. They did not necessarily have a preconceived idea of a topic to be investigated. The model could also be investigated in the form of pure mathematics. New ideas then emerged from this mathematical investigation. With the development of QM, at the latest, this has become the leading approach in physics. This approach, which has been pursued very intensively for over 100 years now, has been extremely successful. Without it, we would certainly not be where we are today in physics. However, I also believe that this path has been exhausted. We have reached a point where we need to reverse the approach. New ideas are needed, which can then be investigated later using mathematics.

The why and the how are both important. The reasons given should be understood to mean that in this description, the idea, the why, is considered more important than the mathematical calculation, the how. A compelling logical connection must be created between the descriptions and the effects. This is particularly important as we will be rethinking some of the fundamentals. We explicitly do not want to create a model like QM, where almost everything can be predicted very accurately using very complex calculations. However, we have no idea why this reflects the experimental findings at all.

Enough of the preamble and introduction. From here on, everyone should be able to decide for themselves whether it is worth their lifetime to familiarize themselves with the ideas of DP.

2 Spacetime density as the basic idea (approach)

The first steps in the development of DP were based on several different starting points. None of these was the approach we will be building on here. Over time, the various approaches converged on this point. That was the moment when a theory was formed from a collection of loose ideas.

The basic idea is the continuation of an ingenious thought by Einstein. In addition, this idea is taken to an absolute extreme. If gravity is represented as a purely geometric description in spacetime (spacetime curvature), then we must "simply" apply this idea to everything else.

Then everything is a geometric representation in a single object, spacetime.

2.1 Motivation

How did we come up with such a bizarre and extreme idea of wanting to map everything onto a single object? What we want to achieve is the unification of GR and QM. However, this task is proving to be a very tough nut to crack. The brightest minds have been trying to do this for over 100 years and have not yet found a truly valid solution. More voices are saying that this may not even be possible. In fact, the idea of unification is only a wish of physicists. No one can say with certainty whether it is even possible. Therefore, the steps towards unification are becoming smaller. Very specific properties of possible unification are being investigated. Our approach is the exact opposite of this.

We assume that unification is fundamentally possible and select the most extreme form from the possibilities. Those who embark on the search for the Holy Grail do not question its existence. But the question arises: Is there any indication that the approach of "everything is an object with a geometric mapping" makes any sense at all? Well, if I ask the question.

To do this, we start in the physics kindergarten and first look at a small and well-known formula.

$$r_S = \frac{2 * G * M}{c^2}$$

With this formula, we can calculate the Schwarzschild radius of a mass. The black hole of the mass has no charge and does not rotate. This representation of the equation is very consistent with our intuition.

$$r_S = \frac{2 * 6.6743 * 10^{-1} * 6 * 10^{24}}{299792458^2}$$

For the Earth, we arrive at approximately 9 mm. I have simply omitted the units of measurement. The result is a length. Everything is kept very simple. This is an equation and therefore an identity. There must also be a length on the right-hand side. We don't recognize this at first glance because the individual components are not lengths. This means that although the gravitational constant, the mass, and the speed of light on the right-hand side are not lengths, we can combine them to form a length. Now for the physics kindergarten. Why are we allowed to do this? These are very different objects and none of them are lengths. We don't think about it for long. If the units of measurement are identical, we can compare both sides. Therefore, we can also describe the Schwarzschild radius with other objects. We "only" must obtain a length with the identical result.

Therefore, we have chosen a rather unusual representation.

$$r_S = \frac{2 * {l_P}^2}{\lambda_C}$$

l_P refers to a Planck length and λ_C refers to a Compton wavelength. Here we need the Compton wavelength of the Earth. If anyone wants to check this calculation, I always leave all Planck units and h unreduced (not divided by $2 * \pi$). For the Compton wavelength, we assume a scattering angle of 90 degrees so that the cosine drops out of the formula. This gives us:

$$r_S = \frac{2 * 1.6413 * 10^{-69}}{3.6837 * 10^{-67}}$$

We get our approx. 9 mm again. This time we only used lengths. Seems much more "natural." However, the lengths used are the Planck length and the Compton wavelength. These are objects from QM and not from GR. It works anyway. With this different representation, we obtain additional information.

Example: We know that there cannot be a Compton wavelength smaller than the Planck length. Otherwise, the energy would have to lead directly to a black hole during scattering. If we enter l_P instead of λ_C in the above formula, the lower limit is a Schwarzschild radius of two Planck lengths. This appears to be a lower limit for a Schwarzschild radius. We cannot see this relationship from the first representation. The fact that we can choose different representations is therefore very useful for us.

We can choose another representation. Here, M_E is the mass of the Earth and m_P is the Planck mass.

$$r_S = 2 * l_P \frac{M_E}{m_P}$$

$$r_S = 2 * 4.0513 * 10^{-35} \frac{6 * 10^{24}}{5.4555 * 10^{-8}}$$

We again obtain our approx. 9 mm. In this representation, it appears that the Schwarzschild radius is only twice the Planck length (i.e., the smallest possible value), which is changed by a factor of a mass ratio. Since the Schwarzschild radius cannot be smaller than two Planck lengths, a mass smaller than the Planck mass cannot form a black hole. Again, new information. Somehow, we can always arrive at a representation with length and mass. We can rearrange the last formula slightly and obtain:

$$\frac{r_S}{l_P} = \frac{2 * M_E}{m_P}$$

Now it is a length ratio to a mass ratio without a unit of measurement in comparison. It seems that representations in our spacetime, such as a Schwarzschild radius or a mass, must adhere to certain limits.

Let's take a second well-known example. But now we'll start with a formula for specifying a ratio. In other words, a result without a unit of measurement.

$$F_{Elekt} = \frac{e^2}{4 * \pi * \varepsilon_0 * r^2}$$

$$F_{Grav} = \frac{G * m_1 * m_2}{r^2}$$

The first formula is the classic description of static electric force. The second formula is the classic description of gravity as a force. Presumably, no one will have a problem with the next steps. We substitute the mass of an electron for m_1 and m_2 and the elementary charge of the electron for the charge e . Then we put the two equations in relation to each other, because both equations have the same unit of measurement.

$$\frac{F_{Elekt}}{F_{Grav}} = \frac{\frac{e^2}{4 * \pi * \varepsilon_0 * r^2}}{\frac{G * m_1 * m_2}{r^2}}$$

r^2 cancels out, and then we plug in the numbers. This gives us:

$$\frac{e^2}{4 * \pi * \varepsilon_0 * G * m_e{}^2} = 4 * 10^{42}$$

This is an extremely large number. This means that the difference between the forces of gravity and the electric field is a number with 42 zeros. We can check this with a rough estimate. Take a small, weak refrigerator magnet and use it to lift a metal paper clip. The result is that the magnet exerts a stronger electric force than the entire Earth with its gravity. The result is correct and accepted by all physicists. If you have seen a different, and in any case smaller, number, this is not a problem. It depends on which particle is used for the mass. We take the electron, as this is the smallest particle with a charge in terms of mass. We will need the calculated number with the electron again later.

Here, we have compared gravity as a force and the electric field as a force. However, these fundamental forces should not be compatible. Many objections may now arise. It is only old classical physics, gravity is not a force, no example from quantum mechanics, etc. All objections are correct. The principle of the first example applies: if the units of measurement match, we can compare the mathematical expressions. The principle applies to all units of measurement, and there are many of them. It does not matter where the description as a formula came from. If we manage to make the units of measurement match, we can compare them.

Here we can again choose an unusual representation. With α as the fine structure constant.

$$\frac{F_{Elekt}}{F_{Grav}} = \frac{1}{2 * \pi} * \alpha * \left(\frac{m_P}{m_e}\right)^2 \Leftrightarrow \frac{F_{Elekt} * 2 * \pi}{F_{Grav} * \alpha} = \left(\frac{m_P}{m_e}\right)^2$$

None of the individual terms has a unit of measurement, and yet everything fits together. A force ratio, with a correction factor for each force, is nothing more than a mass ratio squared. If you remember the first formula, we could also use the square of the Schwarzschild radii. It appears that we can choose almost any representation for the identical statement here.

We will try to formulate our findings from the two examples into a new idea. In physics, there is only one object, and the unit of measurement is only a certain view of this object. We look at the identical object and put on different glasses. Then it is logical that if we can compare terms that we have converted to identical units of measurement. It is all the same.

When unifying GR and QM, these units of measurement are very different. In GR, there is a length in the curvature of spacetime. In QM, there is a probability. But a probability is not a unit of measurement at all. These are very different pairs of glasses. This is where the problem and the solution lie. Although we start with the idea of a single object, we will find that QM considers something completely different from GR. Therefore, there will be no unification as a mathematically identical description. On a logical level, both theories are integrated into a comprehensive unified framework, Dimensional Physics.

2.2 Structure of Einstein's field equations

We need to set some kind of "anchor" as a starting point. We don't want to create a completely new description, like string theory. We want to combine the descriptions given of GR and QM. The idea is to work with only one single object. In fact, with GR, the first half is already done. Therefore, contrary to the entire mainstream in physics, we start with GR. Since we started from GR, we take the characteristic equation for GR in its simplest form: Einstein's field equations.

$$G_{\mu\nu} = k * T_{\mu\nu}$$

Let's take a closer look at the structure of the equation.

2.2.1 System of equations

The first thing that stands out: Why field equations? There is only one equation. This notation is very compact. There are 16 individual equations that together form a system of equations. The Greek letters μ and v count from 0 to 3 (this is the convention). Each letter stands for the number of dimensions in our spacetime. Textbooks count 4 dimensions for our spacetime. Three spatial dimensions and one temporal dimension. In fact, there are 4 spatial dimensions in the equation. The temporal dimension is given an additional factor, which turns time into a length. In the mathematical description, the unit of measurement for the temporal dimension is a length and not time. The time dimension is given a different sign than the spatial dimensions. Spatial dimensions are given a plus sign, and the time dimension is a minus sign, or vice versa. How this is done is purely a matter of opinion. The important thing is that the signs are different. This is called the signature of spacetime. We use the signature (- + + +).

The capital letters are tensors. They describe how the content of the tensors behaves from one dimension to another. This results in 4 * 4 possibilities = 16 equations. However, due to symmetries, we only need 10 independent equations.

Contrary to the textbook, we will only count the real spatial dimensions, i.e., those with +. This makes our spacetime 3D. Why we do this is explained in Chapter 3, "Limits of Spacetime." The additional time dimension results automatically for any spacetime configuration. We will see that this signature alone is not sufficient for classifying spacetime.

2.2.2 Left side G, the spacetime curvature

The left side of the equation only has the tensor with the designation G, the Einstein tensor. This describes, let's call it very generally, a deformation of spacetime itself. This type of deformation is called spacetime curvature. In GR, spacetime curvature is equated with gravity. Thus, gravity is not a force or interaction, but a geometric mapping onto a single object, spacetime. Our approach is to obtain a geometric identity across all considerations onto one object. This already achieves the desired form of description for gravity. This immediately raises the question of whether we can achieve the same for the other side of the equation.

2.2.3 Right side T, the space-time density

We transfer the idea of a mapping in spacetime to the other side of the equation. There we have two elements. First, the small k. This is a proportionality constant. It contains only fixed values and thus, in a mathematical sense, represents only a fixed number with the appropriate unit of measurement. We will examine this k later. Then there is the stress-energy tensor T. This contains everything that is referred to as mass-energy equivalent. As with G, it is divided between the respective dimensions.

Without even noticing, we have already achieved our goal. Yet it looks like the opposite. The stress-energy tensor is a wild collection of everything the universe has to offer without gravity. How can an equation with such a collection of vastly different objects be represented so clearly? Because the collection is not as wild as it looks. Let's close our eyes, and I mean all mathematical eyes, and look at the equation as a union of GR and QM. G describes gravity and T collects the entire particle zoo from the Standard Model, plus momentum, charges, etc. We know that the descriptions do not match, and yet we still have an equal sign here. For this equation to work and for the difference to QM to arise, GR must adopt a special view of this collection of mass-energy equivalents. The differences must be normalized or, to put it bluntly, the right side must put on the right glasses. As is so often the case in physics, this is done via energy. No matter how different the contributions from the stress-energy tensor are, GR must adopt a normalized perspective. GR may only be interested in two things from T: the amount of energy and the possible alignment with the dimensions. Any "internal structure" of a mass-energy equivalent (whether it is an electron, photon, proton, etc.) must be ignored.

This is an equation. Therefore, the units of measurement are identical on both sides. The Einstein tensor only uses spacetime with deformation. The unit of measurement is a specification of length. We do the same with the stress-energy tensor. A geometric mapping in spacetime with the unit of measurement being length. Certain requirements are placed on this geometric mapping in the stress-energy tensor. The equation must continue to work, and all statements of general relativity about gravity must follow from it. For some of the statements, the mapping must already match quantum mechanics at this level. That sounds like a very difficult geometric mapping in spacetime. The opposite is true. We will assume an evenly distributed "density" of spacetime itself in a specific spacetime volume.

The deformation of spacetime for gravity is called spacetime curvature. Then we also need a name for the deformation on the other side of the equation. Therefore, by sovereign arbitrariness => the deformation of spacetime for a mass-energy equivalent is called: **spacetime density**. The term "density" describes this deformation very well in certain places, but in other places it is rather misleading. The name density is intuitively based on everyday experience. The density of spacetime is defined differently from the density of any substance. However, we must give it some name. So, we will stick with spacetime density as the source of spacetime curvature.

2.3 Assumptions in DP

We only need four assumptions to provide a complete description of physics:

- New in DP: **All objects and phenomena known to us are geometric images in spacetime.** The number of possible deformations is very limited. There is only spacetime curvature, spacetime density, and the respective opposite deformation. For a complete representation of physics, especially QM, we will need spacetime configurations other than our spacetime. Our spacetime does not have the structures required for QM. However, these spacetime configurations necessarily result from our approach and do not need to be postulated additionally. Again, there are only the known deformations. We do not need anything else.
- Old from GR: **Every spacetime must be continuous and differentiable.** Motion is a form of energy. If we want to map this directly in spacetime, then the state of motion must be mappable in spacetime. The mathematical terms for this are continuous and differentiable. Even for the description within QM, e.g., for the tunnel effect, this property of spacetime will become important.

- Controversial whether old or new: **Every spacetime is a kind of substance.** Spacetime is a very special substance and behaves differently than we are used to with substances. According to GR and DP, spacetime has spacetime curvature, spacetime density, expansion, gravitational waves, and, in the case of rotation, also a "drag." This looks very much like a substance and not just a mathematically abstract construct. Since Einstein, it has been a popular philosophical point of contention whether space and time are an abstraction or something real. We are committing ourselves here to an extreme point of view.
    - The only things that exist are spacetimes.
    - The only thing we can perceive are the deformations in spacetimes.
- Whether old or new, it **is** debatable whether **deformations in spacetime always represent a change in the definition of length and time.** Here, too, some physicists disagree. We are 100% certain that these deformations represent a change in the definition of length and time, which later results in the principle of relativity or the constancy of the speed of light.

We will see that the conclusions drawn from these assumptions will lead us to the description of physics that we are familiar with. If someone had told me this before the DP was developed, I would have thought they were crazy. However, this approach has a major advantage for testing the DP. There is almost no choice in the conclusions. Either the logic is correct, or the entire theory collapses. There are very few places where there is still room for "extensions." The possibilities found in other theories, with smaller structures, higher energies, higher masses, additional particles, symmetry breaking, etc., do not exist here.

We could even derive spacetime as a substance, with the properties of continuity and differentiability, from the assumption of spacetime density. We will leave our approach divided into these four points. This is better for understanding. Thus, the only real additional assumption to known physics is spacetime density. What could really change? Almost everything, without really having to adjust the mathematics. As I said, it sounds a bit crazy.

2.4 Spacetime density

We have introduced spacetime density into the world. Then we should do two things first:

- A more precise definition of what this spacetime density is. A full understanding of spacetime density will only be developed in Chapter 3. Only together with the boundaries of spacetime does a complete picture emerge.
- At a high level, an initial examination of whether the elementary properties of GR result from it.

2.4.1 Spacetime curvature

Let's not make life more difficult than it is and start with something familiar. Spacetime curvature has been known for over 100 years and is well understood mathematically. Spacetime density is the source of spacetime curvature. We can therefore see spacetime curvature as the reaction of spacetime to spacetime density. This behavior is described by the field equations. The definition of spacetime density must be consistent with the existing solutions to the field equations.

In this text, we always use Schwarzschild's solution to the field equations. This has advantages but also disadvantages. The big advantage is that this solution is the simplest. Schwarzschild found this solution only a few months after Einstein's publication. It is a vacuum solution for non-rotating masses. We are sure that this is a strong simplification. However, it is sufficient for our purposes.

In order to understand the solution, we need to write down the signature of spacetime (- + + +) in full. The signature is simply a shorthand form of a metric. The metric of spacetime defines the behavior of spacetime in relation to the field equations. In a sense, the metric is the solution to the equation. 4 x 4 entries for all the different divisions between the dimensions. Equally important for us: Metric is the appropriate **definition of geometry** for spacetime. Schwarzschild metric:

$$
\begin{matrix}
-c^2\left(1-\frac{r_S}{r}\right)dt^2 & 0 & 0 & 0 \\
0 & +\frac{1}{(1-\frac{r_S}{r})}dr^2 & 0 & 0 \\
0 & 0 & +r^2 d\theta^2 & 0 \\
0 & 0 & 0 & +r^2 sin^2(\theta)d\phi^2
\end{matrix}
$$

Don't panic, it looks worse than it is. In the diagonal of this matrix, you first see the signs from the signature (- + + +). Behind them, however, there is a term in each case. The last two terms with θ or ϕ are not relevant for us at the moment. This solution is based on spherical coordinates. The last two entries indicate the position on a spherical surface. Like the longitude and latitude on the Earth's surface. However, we are only interested in the distance, i.e., the radius of this spherical surface, and not the position on it. Fortunately, in the case of gravity, the effect only depends on the distance. This means that only the first two terms are of interest.

The first term is the time dimension. This can be seen from the dt^2 and the minus sign. However, this term is multiplied by a c^2. Speed is a length divided by time, and the time dimension is only a time. After simplification, only a length remains. In mathematical terms, the time dimension is converted into a spatial dimension. There are 4 spatial dimensions. We will stick to the terminology used in textbooks and still refer to it as the time dimension. The small r is the distance from the gravitational source and the r_S is the Schwarzschild radius. The event horizon of the black hole.

The second term is the radial distance to the gravitational source. You don't have to be a mathematical genius to see that the second term is the reciprocal of the first term. This means that the time dimension and the space dimension behave in the same way but in opposite directions. If you are far away from the gravitational source, the distance r from r_S is large and the fraction $\frac{r_S}{r}$ approaches zero in the time and space dimensions. This means that there is actually only a 1 in the parentheses and we have flat spacetime and no gravity. However, gravity never becomes exactly zero. This means that gravity has an infinite range. As we approach r_S , the fraction approaches 1. At the Schwarzschild radius, it is exactly 1. In the time dimension, the parentheses become zero. The time dimension then has no more extension/length. Time stands still for a distant observer. In the radial space dimension, the parentheses also approach zero. However, it is then divided by zero and we obtain a singularity. A value of infinity, or rather undefined. This is another disadvantage of the Schwarzschild metric. With other metrics, this singularity does not occur at the event horizon. It can be shown that this is only a peculiarity of this metric, a mathematical artifact. Since the parentheses are in the denominator for the radial component, the extension/length before the Schwarzschild radius approaches infinity.

If the time and space dimensions form a rectangle, the following happens:

Figure2: Spacetime without curvature

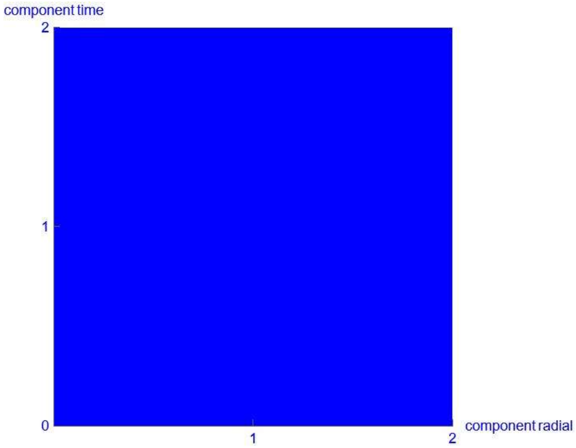
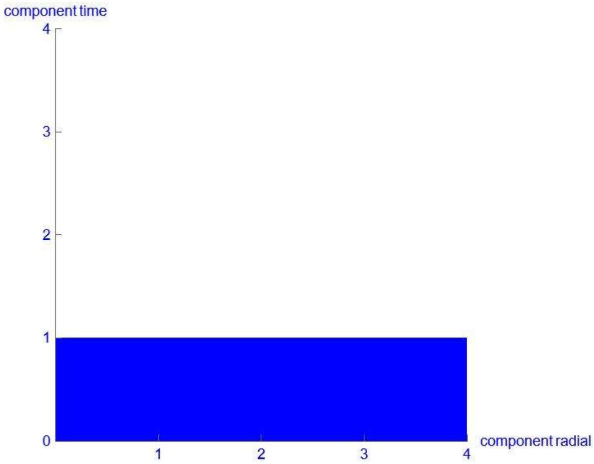


Figure1: Spacetime with curvature



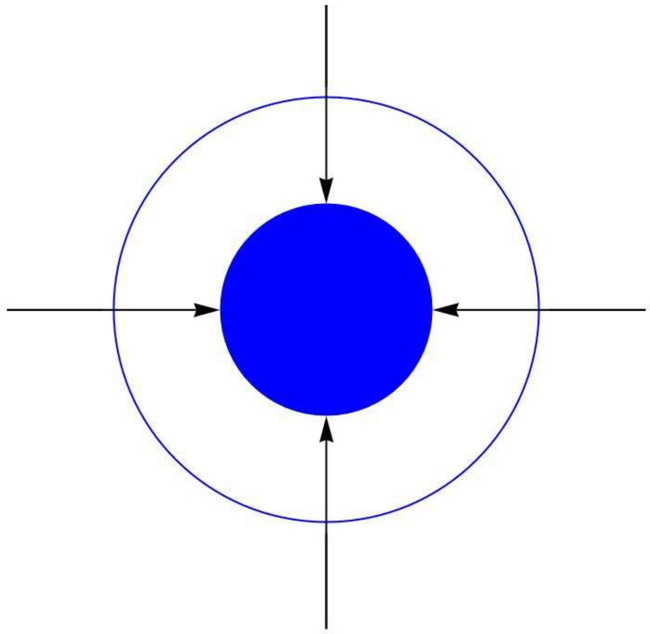
The time dimension becomes smaller and the space dimension becomes larger to the same extent. The key point here is that the area of the rectangle does not change. If the time is halved, the length doubles => identical area. This consideration of spacetime curvature is sufficient for us to justify our deformation as the source of spacetime curvature, the spacetime density.

2.4.2 Why a density?

Let's stick with a spherically symmetric example. If the radial space component in the direction of the gravitational source becomes longer and longer, where does this additional length go? What we often hear is: into the curvature of spacetime. We want to describe the curvature of spacetime as a reaction to the density of spacetime. So, let's turn the argument around. It's easier if we assume that the spacetime of the gravitational source has shortened with some deformation. The spacetime curvature must compensate for this with additional length.

If you like, due to the continuity of spacetime, the curvature of spacetime fills in the missing expansion of spacetime to spacetime density.

Figure3: Spacetime curvature compensates



We are looking at a spacetime volume and still have the spherical coordinates. In a space-time volume, however, it is not only a length that can become shorter due to deformation. The entire spacetime volume of the gravitational source must become smaller. We continue to assume identical behavior of spacetime during deformation. Then, in addition to the radial spatial dimension, the time dimension must also change to the same extent. Not in the opposite direction, otherwise we will not obtain a smaller volume. In this case, the time dimension must shorten to the same extent as the spatial dimension.

Figure5: Spacetime without spacetime density

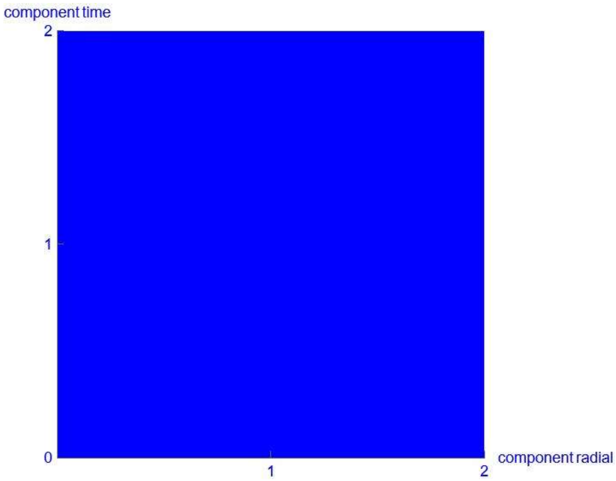
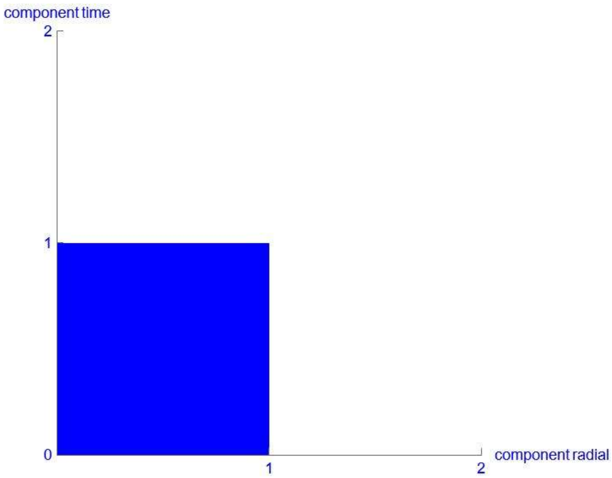


Figure4: Spacetime with spacetime density



The deformation of spacetime for the gravitational source looks like a "density." The previously larger area must now be accommodated on a smaller area.

Hence the name: **spacetime density**

2.4.3 What becomes denser in spacetime?

How should we imagine this density? With a material such as a sponge, we can squeeze it and very easily recognize its density. Does the same happen with spacetime? Clearly not! When talking about density, we like to use the analogy of a substance. In a substance, we can recognize the density from the outside and also determine it within the substance itself. As with the sponge. The analogy of a substance is like the word density. Sometimes it fits and sometimes it doesn't. In this case, neither substance nor density fits colloquial usage. Because nothing is being "squeezed." In the images above, we simply shortened the lengths. That doesn't happen. What really happened is that the **definition of geometry** changed.The fact that the **definition** of spacetime geometry changes and nothing is stretched or squashed cannot be emphasized enough. This is a key point for a understanding of DP. We redraw the two images of spacetime density with the correct divisions on the coordinates. It then looks like this:

Figure7: Spacetime density without density

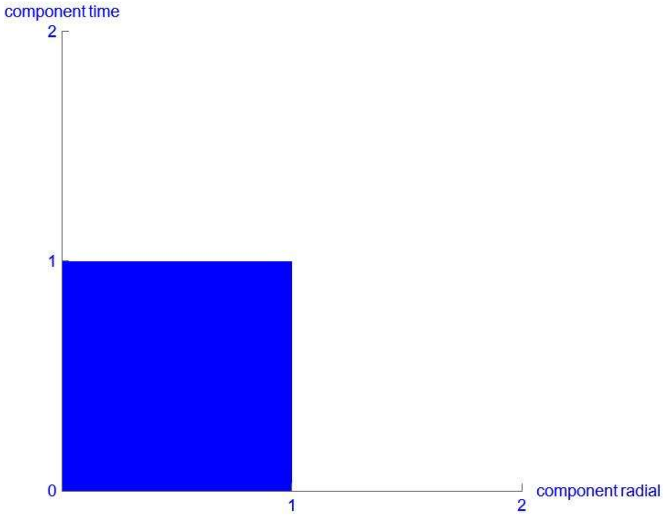
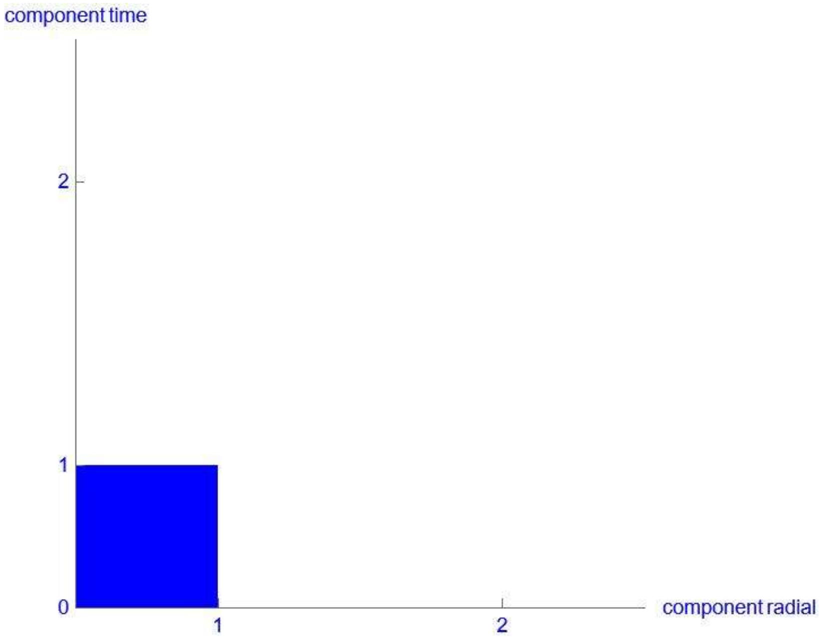


Figure6: Spacetime with density as a definition



Can you see the difference? The step size of a unit of length remains 1 in both images. What has really changed here is how a meter is **defined** for a spatial dimension and a second for the time dimension. This is only within the spacetime density. This means that each rectangle has an area of 1. Locally, there is no change. Only when comparing the rectangles can one see that the **definition** of time and length must be different.

Spacetime density is actually a **"density of the definition of the geometry of spacetime"** or a **"density of the spacetime definition**." These are long terms or obscure abbreviations. We'll stick with spacetime density.

Five times in bold: **"definition**." I hope that has stuck. Nothing is condensed as it would be with a substance. In the metric of spacetime, there is no classical expansion or density. The definition of what the unit of length 1 meter or the unit of time 1 second is, is changed. This shorter definition is the higher density. Only with this view of the definition can we later construct a principle of relativity and derive the important conclusion of the "limits of spacetime."

We can also do this with the sponge.

Figure8: Sponge as an object with normal density

Figure9: Sponge as an object with increased density

Figure10: Length definition on a sponge

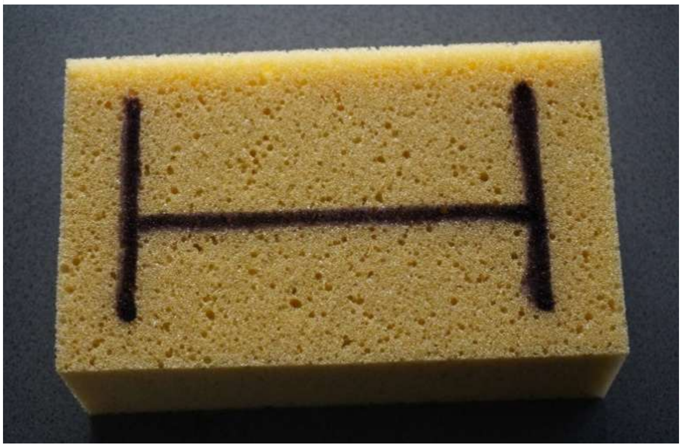


Figure11: Increased length definition on a sponge

What has just been said about spacetime density also applies to spacetime curvature. Here is the spacetime curvature with the correct divisions in the drawing:

Figure13: Spacetime without curvature

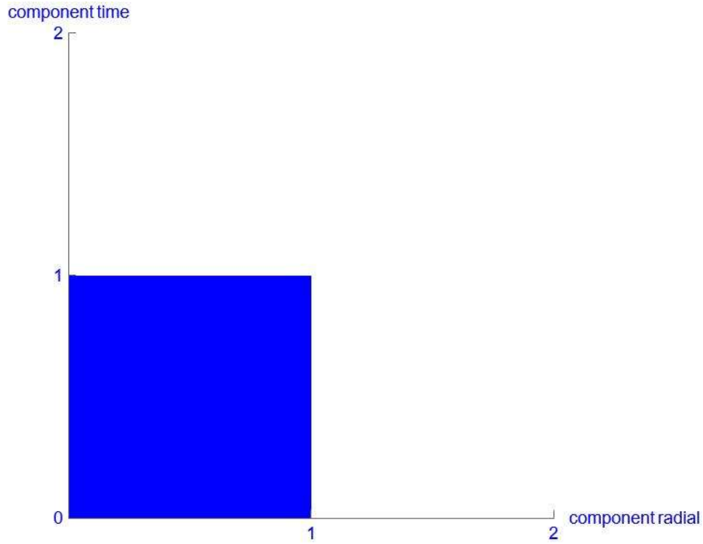
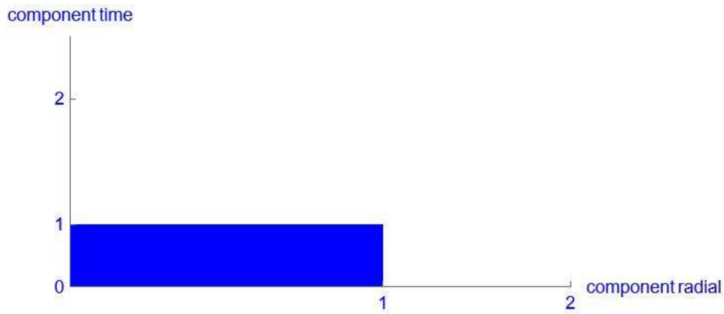
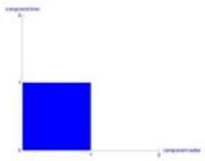
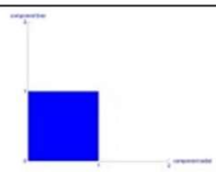
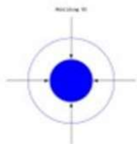
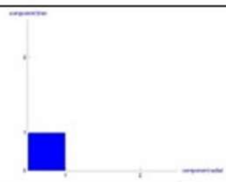


Figure12: Spacetime density with appropriate units of measurement



There are more names to define. In SR, the individual components have been referred to as length contraction and time dilation. We will continue to use these terms in exactly the same way. For spacetime density, time dilation is used for the time dimension and length contraction for the space dimension. In the case of spacetime curvature, the time dimension is also defined as smaller, which means that this is a time dilation. However, there is no separate term for the change in the spatial dimension in spacetime curvature. In this case, the term spacetime curvature is often used directly. From now on, we will only use spacetime density and spacetime curvature to describe the behavior of the entire spacetime. In order to remain consistent with the same syntax, we will use the term length relaxation for the change in the spatial dimension in spacetime curvature.

Figure14: Overview of spacetime deformations

GR from the DP's perspective		
$G_{\mu v} = k * T_{\mu v}$		
Deformation =	**Everything is space-time**	**= Deformation**
Homogeneous space-time		**Homogeneous space-time**
		
space-time curvature • **time dilation** • **length relaxation**		**Space-time density** • **time dilation** • **length contraction**
		
No change in space-time density **inhomogeneous**		**Change in space-time density** **homogeneous**

2.4.4 A brief philosophical aside

Every individual, every planet, and even every single elementary particle is a spacetime density in a single object, spacetime. This is continuous. There are no boundaries within spacetime. According to DP, we are all together and physically speaking, completely correct, just different spacetime densities in a single spacetime. This approach thus represents the strongest collective thought we can apply.

QM will have a slightly different opinion on this. However, for GR, this is 100% true. We should always keep this collective thought in mind when dealing with other individuals. According to DP, this is always a way of dealing with ourselves. The thought is as beautiful as it is frightening.

2.5 Initial examination

At the end of this chapter, we want to test our assumption of spacetime density at a high level. We only need to be able to explain the behavior of GR based on geometry. The mathematics, the how, will not be changed. Our goal is to be able to explain the why to mathematics. The assumptions that led to SR and GR, the principle of relativity, the speed of light, and the equivalence principle are discussed in separate chapters. This will be the actual test. We must be able to generate these assumptions from our approach. We cannot reuse them, otherwise we will end up with a circular argument. The starting point was already GR. Let's go through a few points.

2.5.1 Alignment of Gravity

For us, spacetime curvature is the reaction of spacetime to spacetime density. Since spacetime density "contracts," spacetime as a continuum must compensate for this. The curvature of spacetime must necessarily align itself in the direction of the spacetime density. In the first approach, the spacetime density has no direction. A density can be described as evenly distributed over the volume. This makes the curvature of spacetime a vector quantity and the spacetime density a scalar quantity. In the next chapter, we will derive that a spacetime density can be scalar and vectorial.

2.5.2 Mutual cancellation

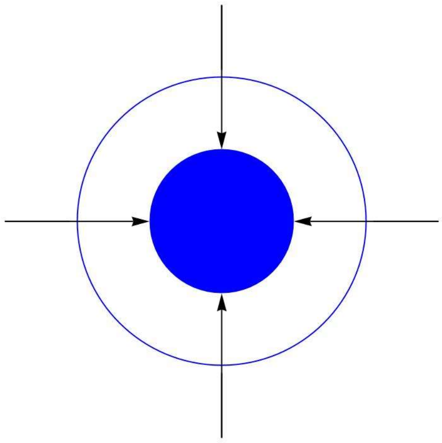
We can rearrange the formula of the field equations. We bring the Einstein tensor to the same side as the stress-energy tensor. This rearrangement is allowed for any equation.

$$\mathbf{0} = \boldsymbol{k} * \boldsymbol{T_{\mu\nu}} - \boldsymbol{G_{\mu\nu}}$$

Now the spacetime density and the spacetime curvature must cancel each other out. A sign change for a geometric mapping is always a change of direction. This means that the space curvature now pulls away from the spacetime density. The spacetime density is now "pulled apart" by the spacetime curvature. This is no change for spacetime, i.e., it is equal to zero.

2.5.3 Infinite range and decay with r^2

Let's take another look at Figure 2-3. Memorize the image well, as we will need it again later.



We see that the spacetime curvature deforms spacetime toward spacetime density. This means that the spacetime outside the ring must be deformed toward spacetime density. Spacetime is a continuum and must not be „tear".

If something deforms in one direction, then the neighboring area must also deform in that direction. Then the neighboring area of the neighboring area must deform, and so on. Therefore, the spacetime curvature must have infinite range.

The effect of gravity decreases with distance. This decrease must be greater than linear. With distance away from a spacetime density, spacetime curvature can access an ever-increasing spacetime volume that must deform. Therefore, the attenuation in our 3D spacetime must occur with the square of the distance. In the opposite direction of gravity (away from the spacetime density), a one-dimensional space dimension is added to the volume by two spatial dimensions. If we consider the blue ring as a spherical shell in 3D, we can place ever larger spherical shells around the spacetime density. The distance r of the spherical surface on which gravity acts grow linearly. However, the surface itself grows with r^2. The spacetime curvature can use the distance from point to point to compensate for an ever-increasing surface area. This means that this growing surface area has to counteract this less and less, and the spacetime curvature decreases with r^2.

2.5.4 Spacetime curvature without change in spacetime density

Let's stay with Figure 2-3. We can see that space-time must "follow" the spacetime density with the spacetime curvature. Spacetime must compensate here. Then it only makes sense for spacetime if the pushing is done by the spacetime curvature in such a way that the spacetime density of the surrounding spacetime does not change due to the spacetime curvature up to the gravitational source. The spacetime curvature must therefore be a deformation of spacetime that does not itself cause any change in spacetime density. Even "empty" spacetime without a particle is spacetime and therefore has a spacetime density. Based on the approach with spacetime density, the spacetime curvature must exhibit the known behavior. The area of spacetime does not change, and the spacetime density at the spacetime curvature therefore does not change either.

2.5.5 No resolution of space-time density

Let's stay with Figure 2-3. We can see that spacetime must "follow" the spacetime density with the spacetime curvature. Spacetime must compensate here. Correct! The beginning repeats itself. This is not a mistake. We need these statements again here.

The spacetime curvature must compensate for the gap between the ring and the disk. However, this also means that the spacetime curvature must explicitly not compensate for the spacetime density. For the spacetime curvature, the end is reached at the boundary of the spacetime density. There is already too much spacetime in the spacetime density. The spacetime curvature must not extend into it and exacerbate the problem.

Important! Spacetime curvature is not there to set spacetime density to zero. Due to the continuity of spacetime, it must compensate for the missing length up to spacetime density. Spacetime curvature should not dissolve spacetime density. Only the amount of spacetime density is relevant for spacetime curvature, since a larger spacetime density must compensate for a larger gap. Whether spacetime density has an "internal" structure is completely irrelevant for spacetime curvature and thus for GR. QM will then describe precisely this "internal" structure.

Spacetime curvature is a compensation for a "spacetime gap" caused by spacetime density. Spacetime density itself is not changed by spacetime curvature. Spacetime curvature ends at the boundary of spacetime density. Here we can already see how we will later get rid of the singularity in GR. Spacetime density without spacetime volume makes little sense. No volume, no density, no gravity, and therefore no singularity due to gravity. We will discuss the mathematical abstraction of a point and thus the singularity in detail in Chapter 3, "Limits of Spacetime."

2.5.6 ART non-linear vs. QM linear

Let's stay with Figure 2-3. We can see that spacetime must "follow" the spacetime density with the spacetime curvature. Spacetime must compensate here. Yes, again!

What we can also see is that spacetime has condensed into a disc due to higher spacetime density. The spacetime density in the disc is irrelevant to GR. The amount of spacetime density determines the size of the disk, and this is what interests spacetime curvature. Thus, the spacetime density in the disk can be assumed to be evenly distributed. The description of spacetime density can therefore be done in a linear description. This will be one of the reasons why QM can be described linearly.

This is not the case with GR. Spacetime curvature does not change the spacetime density itself. However, as we can see, spacetime curvature "pushes" additional spacetime toward the spacetime density. This means that the spacetime density has increased slightly again due to the circular spacetime curvature. This results in a self-reinforcing effect. The mathematical description of GR must not be linear under any circumstances.

The wish of all physicists is that, when GR is unified with QM, GR can possibly also be described linearly from a QM approach. Linear descriptions are easier to solve. In QM, however, the description is extremely complicated from the ground up. It is only because this is a linear description that anything can be calculated at all. The description of GR is not as complicated and is very well understood mathematically. Unfortunately, however, GR is not linear. This means that supercomputers are busy calculating approximate solutions in both areas.

2.5.7 Binding Energy

Finally, we will select a topic that does not belong to GR. We want to see that the approach with spacetime density also applies in other areas of physics. To do this, we will select something that exists in many different forms. We want to cover a broad spectrum. In addition, we choose something that no one sees as problematic. The perspective in physics is set to change fundamentally. This also includes areas that are supposedly considered "understood." The choice fell on binding energy.

Binding energy exists in the atomic nucleus, the atomic shell, between atoms or molecules. Even the release of energy during the merger of two black holes can be explained according to this model. The overall structure has less energy than the individual parts before binding. Let's take the fusion of hydrogen into helium as an example. There are several processes in the sun that convert hydrogen into helium. We will simplify the process greatly. This is sufficient for our purposes.

We assume that hydrogen $H_1$is converted into hydrogen H_3, which then fuses into helium He_4. We are only interested in the result, the helium nucleus.

QM calculates exactly the probability of this fusion occurring and the energy that must be released in the process. The form in which the energy is released is not relevant here. We start our question game: Why? Then you often get two answers.

- Systems with less energy are more stable, and all systems want to achieve a stable and therefore low energy level.
- Quantum mechanics determines with its calculations that this must happen.

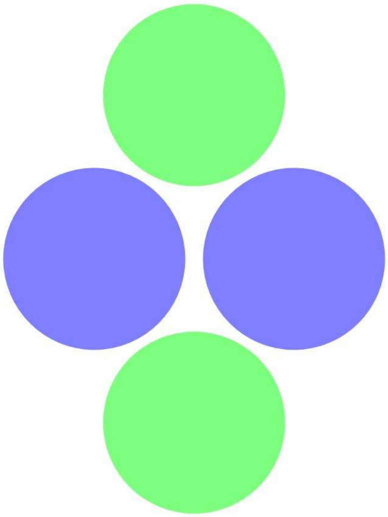
Unfortunately, these are not answers to the question. Why stable energy levels, entropy? The question game can be played for a long time here. What is important for us:

Mathematics is a consistent description of nature for physics, through a suitable model. With this model, we can conduct investigations and make assumptions. **However, mathematics will never create or enforce anything in real nature!** The "why" must clarify this question, and the model description can then add a suitable "how."

Let's explain this using spacetime density. The two H_3 building blocks must be spatially close to each other in order to form a bond. Bonding only works when they are spatially close. In this case, the two building blocks must come so close together that the strong nuclear force can have an effect. We will clarify the exact process of which nucleons are allowed to react with each other later in QM.

The point here is that, in the result, 2 protons and 2 neutrons form a helium nucleus. Textbooks often use a sphere per nucleon to illustrate this. We will try to do the same here. We will ignore the fact that a proton or a neutron are themselves composite systems.

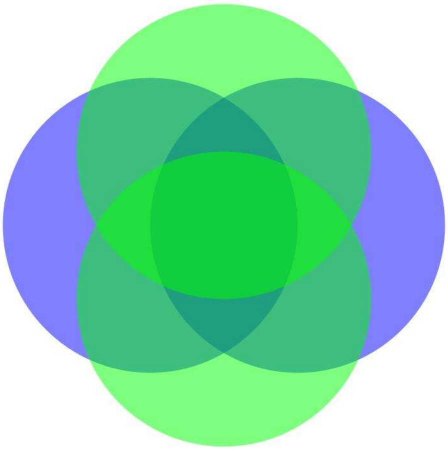
Figure15: Nucleons separated in an atomic nucleus



We now know that the helium nucleus does not look like this at all. Experiments have shown that an atomic nucleus must look more like a single sphere with bulges. Calculations based on quantum mechanics confirm this. How do we get from 4 individual nucleons to a sphere that is not much larger than the individual nucleons? Fortunately, we have our spacetime density.

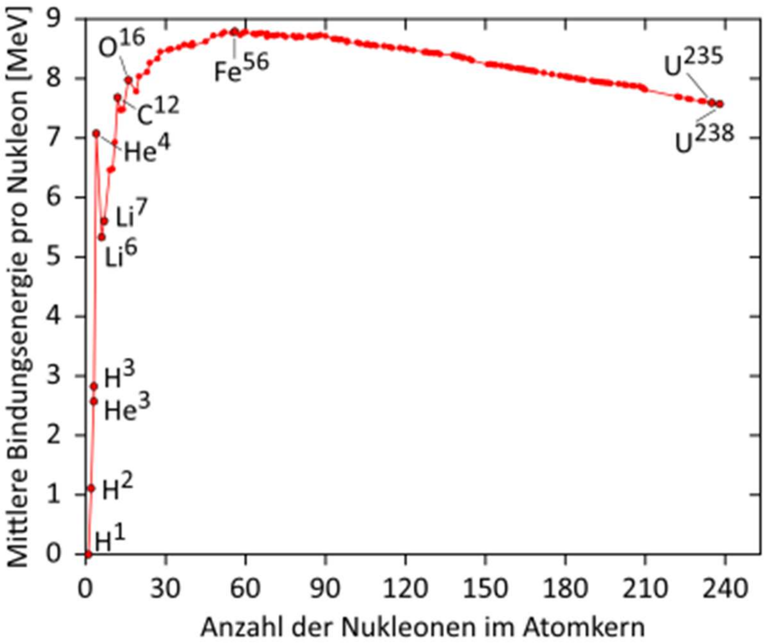
A spacetime density is not a structure with a closed boundary. Everything is spacetime. This means that individual spacetime densities can overlap. Therefore, bonds only work from a certain spatial proximity. To us, the helium nucleus looks more like this.

Figure16: Nucleons overlap in an atomic nucleus



The individual nucleons are a spacetime density. A spacetime density can overlap. With the overlap, each individual nucleon has **too much spacetime density** to be a proton or neutron. In order for the nucleons to remain at their level of spacetime density, part of the spacetime density must be removed. There is too much of it! The nucleons do not want to drop to a lower energy level. The nucleons must remain at their specified energy level. If we want to break this nucleus down into its components, we must restore the missing spacetime density. The spacetime density approach thus explains binding energy very simply. Here is a brief overview of binding energy.

Figure17: Binding energy / *Source reference: https://lp.uni-goettingen.de/get/text/6933*



As we can see, the binding energy increases very sharply with few nucleons. This makes sense, since at the beginning, each individual nucleon creates a new large intersection of spacetime density. The more nucleons already present in the atomic nucleus, the smaller the new intersection between the spacetime densities.

At a certain number of nucleons, the binding energy can decrease again. The repulsion caused by the charge ensures that the nucleons cannot overlap arbitrarily. Therefore, the geometry of the overlap can also result in less binding energy when a new nucleon is added. In iron Fe_{56}, this is the end. Each new nucleon causes a smaller intersection due to the change in the intersections between the spacetime densities.

In addition, there are so-called "magic numbers" 2, 8, 20, 28, 50, and 82. This number of nucleons appears to have a very stable bond. According to QM, when the atomic nucleus is "deformed," these numbers result in an almost exact sphere for the entire atomic nucleus. A smooth sphere as a whole has the highest possible intersection of nucleons.

As we can see, we can use the concept of spacetime density to explain the "why" even in areas outside of GR. This concludes this chapter. In the next chapter, we will look at the most important conclusion drawn from spacetime density: spacetime has boundaries. In this new chapter, spacetime density will be further defined using the idea of spacetime boundaries. But we are not done yet.

3 Limits of spacetime (spacetime structure)

In this chapter, we will derive the most important conclusion from the assumption of spacetime density. Our spacetime, and every other spacetime, has boundaries. From these boundaries, we deduce that there are an infinite number of spacetimes in different configurations. The definition of spacetime density is also described in detail here. The importance of this topic cannot be overstated. The entire field of cosmology and quantum mechanics depends on this topic. Without understanding the boundaries of spacetime, there is no point in even starting the subsequent chapters. Therefore, read this chapter when you have time and peace and quiet. The other ingredients, besides time and peace and quiet, are up to you. I suggest gummy bears and a glass of wine. You may want to read the chapter twice until you have grasped the basics.

3.1 What emerges from the spacetime boundary

Before we go through all the points in detail, here is an overview of what we need to discuss. The number and importance of the points already show you the high priority of the spacetime boundaries:

- The boundaries of spacetime have nothing to do with length or volume. The boundaries lie in the structure of spacetime.
- There is a low-dimensional boundary with the speed of light. Based on certain particles, such as photons, we can determine that there are low-dimensional spacetimes.
- We can only clearly define spacetime density in relation to the limits. Spacetime density then represents the geometry, energy, and state of motion of spacetime.
- There is a higher-dimensional limit with the condition for the formation of a black hole. Since there are black holes in our spacetime, we can determine that we are embedded in at least one higher-dimensional spacetime. This allows us to describe what a black hole is. First, a blunt statement: QM has no relevance in a black hole, since QM maps itself across the lower-dimensional boundary.
- We can conclude that neither the value zero nor the value infinity can exist within a single spacetime. This means that there will no longer be any singularities within GR.
- We can deduce the reason for the existence of natural constants. In doing so, we will find that the gravitational constant is a combination of other natural constants. These are the boundaries of spacetime.
- The boundaries of spacetime are extremely "stubborn" and allow only a very small exchange of information:
    - Beyond the boundaries of spacetime, we cannot recognize normal geometries and must then resort to concepts such as charge.
    - Beyond the boundaries of spacetime, there is no common time dimension.
    - No energy can pass beyond the boundaries of spacetime. A "special form" of energy is required, namely mass.
    - All changes resulting from a low-dimensional process are subject to a quantum of action due to the boundary.
- We can give time a clearly defined meaning.
- We can describe what rest mass is.
- Both boundaries form the basis of cosmology and quantum mechanics. Even though quantum mechanics is mapped using the lower-dimensional boundary, the higher-dimensional boundary plays an important role in quantum mechanics. Somehow, we have to make the leap from a lower-dimensional mapping back into our spacetime. This almost always results in the higher-dimensional boundary that applies there from a lower-dimensional spacetime.

- From the perspective of DP, a very large part of other alternative theories, such as string theory, cannot work.

Some points may not be 100% fully developed. These will then be taken up again in the respective special topics. This mainly concerns the structure of spacetime. In particular, the interaction of different spacetime configurations is described in cosmology and QM.

3.2 Spacetime with a boundary

How did we come up with the idea that spacetime has a boundary? Currently, in 2026, this question is considered unresolved in textbook physics. Based on our everyday experience, absolutely every object has a limited extent. At some point, an object ends and there is then another surrounding space for the object.

This is not the case with spacetime. The reason is simple. Spacetime defines what length or time is. That was our approach to spacetime density. This means that there is no valid definition of distance or time outside of spacetime. This definition only exists within spacetime. The definition may vary in different spacetime configurations, but without spacetime there is no definition of space and time. How then can we define the boundary of spacetime if there is no surrounding spacetime and therefore no "outside" of spacetime?

One possible solution: there may be other spacetimes in which our spacetime is embedded. In this chapter, we will learn that this is indeed the case. However, this environment is of no use to us at all for specifying a distance or time outside our spacetime. A spacetime defines length and time only for itself. From Newton to Einstein, space and time went from being separate objects with absolute specifications to a single object with dynamic behavior of space and time. We go one step further and will have the definition of space and time separately in each spacetime. This means that we can no longer assume that our spacetime defines a distance or time in any other spacetime. Again, each spacetime is its own separate object, which defines length and time only for itself. This will be one of the most important statements in this chapter. This means that we cannot set a boundary from spacetime with a specification of length, volume, or distance. We need another idea.

If we want to examine spacetime as such, then the best way to do so is to look at the deformations of spacetime. As already indicated in the assumptions, we cannot ultimately recognize anything else. How do we proceed? We have reintroduced spacetime density, so let's take a look at its extreme values. For new objects such as spacetime density, it is always a good idea to examine these objects in their extremes.

3.2.1 Spacetime density approaching zero

We want to let the spacetime density approach zero. To do this, the time and space dimensions must let their definitions of length and time approach infinity. Time relaxation and length relaxation. We had defined these names as such. This "counter-deformation" to spacetime density will become important again in the chapter on cosmology. This will result in our expansion of spacetime (not just space).

We do not obtain a limit. The spacetime density decreases but will never become zero. We will clarify this in more detail in a later section. What is crucial for us here is that spacetime has no limit in this case. If this approach does not work for us, then we will try the opposite.

3.2.2 Spacetime density toward infinity

At higher energies, the time and space dimensions approach zero identically to their definitions. This means that the spacetime density becomes larger and larger and approaches infinity. If both dimensions approach zero linearly, the increase in spacetime density must be at least quadratic. However, the already larger spacetime density must be compressed further and further. Therefore, the increase in spacetime density is even exponential with linear time dilation and length contraction. Spacetime density is energy. This has been explicitly defined by our approach (source of gravity). Thus, with a linear increase in energy, the increase in spacetime density will become less and less. The proportion of the increase in total energy continues to decrease with the same amount of energy. Therefore, an exponentially growing amount of energy must be applied for a linear increase in space contraction and time dilation.

In addition, there must be an insurmountable limit to the "shrinking" of the time and space dimensions. Once we have reached zero in the definitions of the dimensions, that is the end. It cannot go any further. Before this limit, the spacetime density must tend toward infinity. In addition, a spacetime density that occupies all spatial dimensions cannot lose a spatial dimension all at once. This is present in spacetime. It must already be determined in the occupation of the spatial dimensions ("internal structure"/QM) whether this limit is reachable or not.

This allows us to obtain a boundary. This boundary behaves in a very peculiar way. The boundary can only be reached if at least one spatial dimension and the time dimension are not occupied by the spacetime density from the outset. If all spatial dimensions are occupied, neither the spatial dimension nor the time dimension can reach this boundary. This is a very strict switch for reaching this spacetime boundary.

What we need is now clear. An absolute boundary within spacetime that cannot be reached by certain objects and is the condition of existence for objects that lie on this boundary. We need time dilation towards zero and length contraction towards zero. We are familiar with this, namely the speed of light. Therefore, the speed of light, as the boundary of spacetime, is a change in the structure within spacetime. Every point in spacetime can experience this boundary. It does not have to be located at an edge. An edge, as with a normal everyday object, does not exist in spacetime. If we remove one spatial dimension, then we must be located at the lower-dimensional boundary of spacetime. Of course, the time dimension is then also zero. If we want to identify spacetime as a single object, then we can no longer have time when we leave spacetime. Space and time are a single object and therefore inseparable. Leaving a spacetime is thus caused by a structural change. Why we can still perceive an object (spacetime density) with the speed of light in our spacetime is another topic for this chapter. Here we want to note:

A spacetime has a boundary

3.3 Speed of light

According to the textbook, the speed of light c is, by postulate of SR, the fixed maximum speed in our spacetime, identical for all observers. This means that it has always been a boundary. What is so special about the DP's view? This boundary is a special boundary. Let's take a closer look at the speed of light.

3.3.1 Definition

As the name suggests, the speed of light is a speed. It is defined as $\frac{Length}{Time}$. The numerical value of the speed of light is purely arbitrary. We have defined it as one meter and one second, and thus the value of the speed of light. Since it is generally accepted that the speed of light is constant, physics reverses the definition. The speed of light is defined, and this results in a definition of the meter and the second. From the perspective of DP, the speed of light can be defined very simply. It is the speed at which time dilation and length contraction reaches zero. This means that the maximum deformation of spacetime for a given spacetime density has been reached.

Why do we obtain a specific value for the speed of light? It should be $\frac{Lengh \quad 0}{Time = 0}$ for the object. This is an undefined mathematical expression and not a specific numerical value. Fortunately, our spacetime has more than one spatial dimension. The representation of the spacetime density of an object moving at the speed of light can therefore only exist in the other two spatial dimensions. A spacetime density must be represented there. But that is not enough. We can only determine a spacetime density as an object. Two spatial dimensions do not result in a space**time** density. The object (e.g., a photon) must have another characteristic for us to recognize this. We will explain this later in this chapter, but in a later section.

We already know that Planck length and Planck time define the speed of light. However, based on the definition, there are an infinite number of values for length and time. Speed is a fraction. It could also be, for example, only half Planck length and half Planck time. This boundary condition alone does **not** explicitly define Planck time and Planck length as the smallest possible units of length and time in spacetime. It is the combination, i.e., the fraction, that determines the speed of light. The important result for us is that there are objects that still exist in our spacetime at this boundary. Thus, this boundary exists for us.

The speed of light is a structural element of spacetime

There is no reason for a postulate of the speed of light as the maximum speed. We will discuss the second part of the postulate, its constancy for every observer, in the principle of relativity. The boundary as the maximum speed for (almost) everything in the universe results automatically from the approach of spacetime density. Since everything that exists is a spacetime density, every object is affected by it.

3.3.2 Low-dimensional limit

An observer recognizes (e.g., for a photon) a movement of spacetime density in the direction of motion with its time exactly at this limit. For spacetime density, which moves at the speed of light, this definition means something else. If an object exists that has mapped its spacetime density to only two spatial dimensions, then this object cannot perceive our 3D spacetime. One spatial dimension must be explicitly missing. But not just one spatial dimension. The time dimension is also missing. Like the spatial dimension, it approaches zero. In the previous interpretation of this fact, no special feature was seen in it. For us, this is different.

One of Einstein's greatest innovations was to unite space and time into a single object of spacetime. Only in this way could the SR and later the GR function. We take this "unity concept" of spacetime 100% seriously and apply it to the speed of light. If we want to leave our spacetime, then time dilation must go to zero. Time is an essential component of spacetime. We have time dilation to zero at the speed of light. Now the behavior of the spacetime components makes sense. Due to length contraction, a spatial dimension always becomes "less or better dense".

We change the space-time configuration from (-, +, +, +) to (-, +, +). In doing so, the time dimension also approaches zero due to time dilation, and the result is (+, +). This is no longer spacetime. There is no time dimension. We have thus left our spacetime. From this consideration, we draw our most important conclusion:

Our spacetime, and therefore all spacetime, has limits. We can define these limits, separately for each spacetime, by saying that the time dimension must approach zero

We already know one of these limits: the speed of light. This is the lower-dimensional limit. Due to length contraction, we lose one spatial dimension at the speed of light. This changes the spacetime configuration of spacetime and takes us out of our spacetime. This is where the analogy with a substance is incorrect. If you change the properties of a substance or an object, it is still the same object. Only with different properties. In spacetime, it is different. If we change the spacetime configuration, with one more or one less spatial dimension, then the time dimension is necessarily set to zero and we leave spacetime.

Then, for example, a photon is a real interface object of our spacetime. It lies directly on the boundary of spacetime. Only because the images of the spacetime density are present on the other two spatial dimensions can we recognize these objects at all. But then, if there is no interaction, only at the speed of light. For a photon, this is the condition of existence and not simply a speed.

3.3.3 Small personal aside

Personally, I am very pleased to know that spacetime has limits and that one of them is the speed of light. A long, long time ago, when I was at business school, I had a physics teacher, Mr. Werner. He fulfilled 100% of all the prejudices and clichés about math and physics teachers. Unfortunately, Mr. Werner passed away while I was still at that school. Towards the end of the first school year, some of the class sat around a campfire drinking beer. It is important to me to emphasize that this did not happen during school lessons. Since I was already interested in physics, I asked Mr. Werner how he came to study physics and how he felt about it. He was not comfortable with quantum mechanics but found general relativity very elegant and beautiful. However, he had a problem with one aspect. This was not the singularity in general relativity, but the maximum speed. The principles of relativity and equivalence seemed logical and easy to understand to him. It was clear to him that all this only works if there is this maximum speed. However, the postulate of the speed of light seemed to him to be a "foreign body" in the theory. He would like to have a logical explanation for this.

Mr. Werner's question has been on my mind ever since that evening and is one of the main reasons why the DP exists. With the approach of spacetime density and spacetime as an object/substance, this question is clarified. The speed of light is not a fixed speed limit. This necessarily follows from the approach. There is no "higher" state of motion than the speed of light. The time and space dimensions are zero. It cannot be any less. The definition of the speed of light must be reversed. It is not at the speed of light that time dilation and length contraction become zero. Reaching the low-dimensional limit of our space-time is the condition for the definition of the speed of light.

The low-dimensional limit is the speed of light.

3.4 Rest mass and energy

It's great that I have found personal peace with the low-dimensional boundary. Does this insight take us further elsewhere? If I ask the question, yes. The low-dimensional boundary, or speed of light, can be chosen as an identical designation and explains the hard switch between objects with or without rest mass and what energy or mass is.

3.4.1 Energy = space-time density

As we approach the low-dimensional boundary, spacetime density approaches infinity. We know this identical behavior from energy. This is no coincidence. In DP, we equate spacetime density and energy. This should be clear from the approach. We define spacetime density as the source of spacetime curvature. The source of spacetime curvature is any form of energy.

Therefore, the identity between energy and spacetime density must necessarily follow. However, this allows us to explain what energy is. Energy is another term for the geometric definition of spacetime itself.

Energy is an identical expression for the geometric definition of spacetime = spacetime density

Here we have two different perspectives or units of measurement for an identical statement. To further deepen this consideration, let's take Einstein's most famous formula:

$$\boldsymbol{E = mc^2}$$

The formula is correct. However, it is only so well-known because the formula in this form is very simple. The complete formula never had a chance to become so well-known because it is somewhat more complicated:

$$\boldsymbol{E = \sqrt{m^2c^4 + p^2c^2}}$$

If the second term under the root is zero, we can take the root and end up back at the familiar part, the rest mass. For the second term to be zero, the movement, i.e., the momentum with p^2 , must be zero. The speed of light c is constant and cannot be zero.

3.4.1.1 Rest mass as space-time density

The first term corresponds to the rest mass. We will not go into this in detail now. To do so, we would need to have a complete understanding of the limits of spacetime. The description of rest mass will therefore come at the end of the chapter.

The part of rest mass that is of interest to us now are two ancient known facts.

- Rest mass is a scalar value. Rest mass does not depend on direction.
- The rest mass is an invariant value and does not change. At least, in the chosen description, when we break down energy into rest mass and kinetic energy.

We will therefore leave rest mass alone until the end of the chapter.

3.4.1.2 Momentum as spacetime density

Let us consider the second term, momentum. In our approach, momentum must have a direct mapping in spacetime geometry. The whole thing with a direction. For us, this means that there must be a spacetime density with a distinguished direction.

For the colloquial term density, an excellent direction sounds a little strange. In a gas or liquid, density is identical in all directions. For spacetime, this is different. Here, we only have the definition of geometry for a description. Spacetime density always lies on the time dimension and on at least one space dimension. For a density in space and time, at least one spatial dimension and one temporal dimension must be involved. Spacetime density does not necessarily have to be mapped onto all spatial dimensions. We need at least one spatial dimension, otherwise the term spacetime density makes no sense. Therefore, different spatial dimensions can have different densities. Thus, momentum is a spacetime density with a distinguished direction in at least one spatial dimension. In the case of angular momentum, the direction is constantly changing, which means a constant change in geometry. We can determine this because an "internal force" must hold the object, e.g., a star, together against this change in direction. However, the spacetime density does not decrease when it remains in place or undergoes a shift in spacetime. It is only shifted to another "direction/spatial dimension." Overall, however, nothing changes.

3.4.1.3 Spacetime density has many characteristics at the same time

So far, we have equated the energy and geometry of spacetime. Now, momentum or angular momentum is also a form of energy. This means that there must be two different descriptions for the definition of geometry. A vector density as momentum and a scalar density as rest mass. But it's not that simple. If the spacetime density characterizes a state of motion, then the rest energy must also have a state of motion. As the name suggests, this is not the case with rest mass. Okay, but then where does the motion point for a rest mass? In all directions at once. Then the motions cancel each other out and the rest mass has earned its name. We will see in the chapter on cosmology that this is the case, for example, with spacetime expansion. For a particle with rest mass, this mass must therefore come from the lower-dimensional interface, otherwise the spacetime density in our spacetime would cancel out to zero. Conversely, this means that the momentum must always lie in our spacetime. This means that the first term for energy comes from the lower-dimensional interface and the second term lies directly in our spacetime. We are narrowing down the definition of spacetime density. Here we can set the following condition:

Spacetime density is energy, spacetime geometry, and state of motion

Space and time have been combined into a single spacetime. We must do the same for these terms. These terms are different descriptions of a single object, spacetime density.

- Geometry describes the direct mapping in spacetime as spacetime density
- Energy is a summary consideration of spacetime density. This has two components. Rest mass as scalar spacetime density and momentum as directed spacetime density.
- The state of motion is the directed spacetime density. A scalar spacetime density (rest mass) can then be further compressed in a specific direction. This is momentum. With a special feature at the speed of light. Here, the direction comes from the absence of a spatial dimension. However, this direction is also distinguished from the other directions. An object traveling at the speed of light therefore has no angular momentum and can only move in one direction.

One more word about motion. The fact that the state of motion of an object is a geometry in the spacetime of the object itself can be described, without restriction, as unusual. We have to get used to this first. If not, all spatial dimensions change identically, we obtain motion in space. This is what we colloquially describe as motion. If all spatial dimensions change identically, this is a change in rest mass or its counterpart, spacetime expansion. In the case of spacetime curvature, with opposing changes in the components, this alters the movement in space and we obtain the "equivalence principle." There is a separate chapter on this. The differences are explained again at the relevant point.

Based on our approach, the fact that we anchor motion directly in the geometry of spacetime should come as no surprise. Spacetime consists only of length and time. Spacetime must therefore be a representation of velocity. No other physical quantity can be constructed with only length and time.

3.4.2 Rest mass = 3D spacetime density

With the current picture of spacetime density, it is very easy to explain why there are objects with rest mass and a state of motion below the speed of light and objects without rest mass and the exact state of motion of the speed of light.

For an object with rest mass, e.g., an electron, the spacetime density must occupy all three spatial dimensions of our spacetime. The speed of light is the low-dimensional limit of spacetime. Our spacetime then loses one spatial dimension. A given spatial dimension cannot simply disappear. It can only continue to increase in directional spacetime density up to the speed of light. The given scalar spacetime density, for example the rest mass for an electron, is continuously compressed in the direction of motion. This results in an energy that increases to infinity. Therefore, reaching the speed of light is impossible.

Space-time density with rest mass = 3 spatial dimensions are occupied

An object without rest mass must not occupy all 3 spatial dimensions under any circumstances. It may only occupy two spatial dimensions. This means that one spatial dimension is already missing due to the "internal structure" of the object. The object must not experience any acceleration. It must already be moving at the speed of light from the moment it comes into existence. No other state of motion is possible without interaction. The object lives in the low-dimensional interface of our spacetime.

Spacetime density without rest mass = 2 spatial dimensions are occupied

From this point, a test for the DP can be generated. If an acceleration phase to the speed of light is ever discovered for an object without rest mass, the DP is falsified.

But wait! Doesn't the interaction with the Higgs field via the Higgs boson give the particles their rest mass? Not quite right! We can see this a little differently. In DP, the Higgs field must correspond to some form of 3D spacetime. In our view, the Higgs boson must be an exchange particle between several such "Higgs fields." We will clarify this in Part 3.

This makes it clear that an object is either one or the other. Only in a "transformation process (interaction in QM)" of the object can the "internal structure (standard model of particle physics)" change. The spacetime density can be redistributed across the spatial dimensions.

Since at the speed of light, the space and time dimensions are already zero, no other spatial dimension can go to zero. The speed of light can only have one direction. From this point, a test for the DP can be generated. No object may have the speed of light in two directions at the same time. We can only set the time dimension to zero once.

3.4.3 Conditions for the speed of light

We can derive the following conditions from the speed of light, which we equate with the low-dimensional limit:

- Only for objects that occupy 2 spatial dimensions and no time dimension
- The direction of the missing spatial dimension is the direction of motion
- These objects can only move in a straight line in flat spacetime. Deviations may occur later in Part 3 on QM. However, these are always instantaneous. The deviation from straight motion appears to us as "faster than light."
- A photon or a gravitational wave, as the best-known objects traveling at the speed of light, cannot have any components in the direction of motion. In the illustration as a wave, these objects must necessarily be transverse waves. Longitudinal waves are not possible because there is no spatial dimension for a component in the direction of motion.
- No acceleration phase to light speed is possible. The speed of light is a condition of existence.
- The speed of light does not exist as a limit because there is a maximum speed. The speed of light is already contained in the structure of spacetime.
- Angular momentum can never reach the speed of light. All three spatial dimensions must be present for angular momentum.

3.5 Black hole

With the speed of light, there is a lower-dimensional limit. Is there also a higher-dimensional limit? One more spatial dimension and no less. The condition for leaving spacetime is time dilation towards zero. This exists in only two places in the universe.

- The speed of light. However, this is the lower-dimensional limit, as one loses a spatial dimension.
- The "singularity" in a black hole. Conversely, this must then be the higher-dimensional limit.

3.5.1 Higher-dimensional boundary

The condition that leads to a black hole must be the higher-dimensional limit. We are very familiar with this condition. If too much spacetime density (energy) is concentrated in too small length, it will turn into a black hole.

This condition, with its specific values, is already known. It is the reciprocal of Planck's force. This is very cumbersome to use as a designation and in the unit of measurement as a force for an explanation. Therefore, we will define this limit differently and choose a more appropriate name. We will do this as we did with spacetime density.

Force of sovereign arbitrariness => **Dimensional constant** with the abbreviation **d.**

This gives the higher-dimensional limit a clear designation. We omit the word "higher" in the dimensional constant. The name "speed of light" is completely ingrained in everyone's mind. We can no longer change this. The lower-dimensional limit cannot therefore be meant by the dimensional constant. Like the speed of light, the dimensional constant is one of the most important natural constants in our spacetime. It is also a structural element of spacetime and not a fixed value.

3.5.2 Definition

The speed of light is defined as $c = \frac{Lengh}{Time}$. For the dimensional constant, it is:

$$d = \frac{Lenght}{Energy}$$

If we add a length to a force (put on different glasses), we obtain the unit of energy. Therefore, for a reciprocal value of the force, the fraction in the denominator and numerator must be extended by a length. This representation is more suitable for explanations and is therefore used as a definition.

In both cases, it makes sense to have a length in the definition. A spacetime density always needs a spatial dimension in order to be able to be mapped in spacetime at all. Both limits are fractions, as they are divisions into a length. The length is in the numerator because we have to accommodate a length in time or energy for a spacetime density to make sense. This will become a general principle. The definition of a natural constant for our spacetime must always include a length.

3.5.3 Minimum and maximum for spacetime

Since the dimensional constant is again a fraction, the same statement applies here as for the speed of light. The length and energy do not specify a smallest length or a largest energy. It can again be half the Planck length and Planck energy. Only the combination of the values results in the dimensional constant.

The values are again known to us as Planck values. We cannot determine the values purely from the speed of light and the dimensional constant. These are two equations with three unknowns. One piece of information is still missing. We will obtain the missing information later in this chapter.

3.5.4 Resistance of spacetime

If one wants to give the dimensional constant an analogy, then it is probably a value for the resistance of spacetime to spacetime density. If this value is exceeded, the spacetime density is too high for our spacetime. Spacetime must enter a range that can withstand this value. This can only be a spacetime with one more spatial dimension. A spacetime with n+1 spatial dimensions is more difficult to deform than a spacetime with n spatial dimensions. We will need this principle in Part 3 for QM.

Our spacetime is already a damn tough piece of work. Small calculation (Note: All values for the Planck units are not reduced, i.e., not shortened by 2π):

Planck length =l_P =$4.051 * 10^{-35}$ meters

Planck time =t_P =$1.351 * 10^{-43}$ seconds

Planck mass =m_P =$5.455 * 10^{-8}$ kilograms

Planck energy =$m_P * c^2 = 4.903 * 10^9$ joules

$$\boldsymbol{d = \frac{l_P}{E_P} = 8.262 * 10^{-45}} \textbf{ 1/Newton}$$

$$\frac{1}{d} = 1.210 * 10^{44} \text{ Reciprocal of d, Newton}$$

No matter what spacetime density we want to use to trigger spacetime curvature, the spacetime curvature is lower by this factor. We have to accommodate a great deal of energy over a small length in order to bridge this value. This is the condition that leads to a black hole. Since we know c with the Planck length and Planck time, the only new value added here is the Planck mass. The Planck energy is calculated. These three Planck values thus determine the limits of spacetime. Here we have to reverse the definition again. The limits of spacetime are determined by these three Planck values and are therefore characteristic values for our spacetime.

Planck length, time, and mass are characteristic values for our spacetime

A black hole is the transition to a higher-dimensional spacetime that can map this spacetime density. Conversely, a lower-dimensional spacetime must have a smaller Planck mass. These different Planck masses for each lower-dimensional spacetime configuration will later be the different rest masses of the particles in the standard model of particle physics.

Each spacetime configuration has its own Planck values for the Planck units

Let's do a little counter-calculation. If we consider d to be the maximum resistance of spacetime, then we should be able to calculate this in a simple way. Let's use Newton's formula for gravitational force:

$$F = \frac{G * m_1 * m_2}{r^2}$$

If we substitute the extreme values for mass (Planck mass) and distance (Planck length) into this formula, then our maximum value must also appear. And so, it does. The reason for this will become clearer later when we discuss the constants of nature. If a statement about physics is to be stable, we often arrive at this statement in different ways. This is always a good sign of its accuracy.

$$F_{max} = \frac{G * m_P * m_P}{l_P^{\ 2}} = 1.210 * 10^{44}$$

3.5.5 Hierarchy problem

In physics, there is what is known as the hierarchy problem. This is a name for the large difference when comparing gravity as a force with electromagnetic force. We did this at the very beginning. The value: $4 * 10^{42}$

This is a very large difference when considered as a force. However, we can easily explain this. All fundamental forces from QM always lie in the low-dimensional. We want to map the entire QM later. According to our logic, a low-dimensional spacetime must be much easier to deform than our spacetime. As we can see, the difference in the resistance of the respective spacetime is very large.

We repeat the calculation, but not with the rest mass of an electron m_e, but with the Planck mass m_P. Let's pretend that a 2D spacetime has the same Planck values as our 3D spacetime. This results in a difference of only 0.00116140 . We know this value as the fine structure constant α. However, this is only the case if we reduce α by $2 * \pi$. This was the additional term we used when comparing electric and gravitational forces. We will encounter these $2 * \pi$ again shortly. The forces would then be identical except for α. We will discuss the fine structure constant in Part 3.

The hierarchy problem is simply the large difference in the resistance of spacetime configurations when there is one more or one less spatial dimension.

3.6 Extreme spacetime curvature and spacetime density

We found the two limits of spacetime by looking at the extremes of spacetime, and it has always been one of the big questions: "How can we imagine zero or infinity?" Mathematically, these concepts are now quite well understood. Physically, however, they repeatedly lead to "strange" ideas. We want to clarify this unequivocally. The result will be that within a single spacetime, neither a value of zero nor infinity can occur in the deformations.

3.6.1 Spacetime density of zero

Spacetime density is a density of spacetime itself. A spacetime density of zero therefore also means a non-existent spacetime. Let's take a closer look at this. In our approach, spacetime density already results from the existence of at least one space and time dimension. Without a space dimension, there can be no representation as density. For us, this means that there can never be a spacetime point with a spacetime density of zero. This spacetime point then contains no extension on a space dimension and is therefore not part of spacetime at all.

- The existence of a spacetime point always implies a spacetime density greater than zero and thus a spacetime volume. In spacetime, there cannot be an energy state of zero.
- A spacetime density of zero means that this spacetime point does not exist within spacetime. This spacetime point is therefore excluded from consideration.
- A spacetime density on the low-dimensional boundary indicates that the mapping of the spacetime density in an n-dimensional spacetime must also exist on an n-1 spacetime. No spatial dimension or spacetime density is possible, even in the limiting case. The same argument applies to the higher-dimensional boundary.

3.6.2 The mathematical point

We have used the term "spacetime point." We will continue to do so. In physics, point sizes are often used in calculations. This simplifies the concept, and particularly the calculations. However, anyone who has read attentively up to this point should have gained the following insight:

There is no point in DP

The mathematical abstraction of a point is defined by the fact that a point has no explicit extension in any spatial dimension. This means that it is not part of spacetime. It cannot have any spacetime density. This also means that it has no definition of spacetime geometry, no energy, and no state of motion. Whenever we talk about a point in spacetime, a point mass, etc., this is a purely mathematical abstraction to simplify the problem or the calculation. In DP, there can be no point size of any kind. Let's turn the argument around. It is not GR or QM that have problems with a point size, but rather the mathematical abstraction of a point has no real representation in physics.

3.6.3 Zero spacetime curvature

We have only considered spacetime density. What about spacetime curvature? Can gravity become zero? From what we have discussed so far, theoretically yes. To do this, we need a spacetime with an absolutely homogeneous spacetime density. If there is no difference in spacetime density from one spacetime point (we continue to use this abstraction) to another, then there is also no spacetime curvature that needs to compensate for anything.

However, we live in a spacetime with varying spacetime densities, otherwise we would not be able to discuss this here. Spacetime curvature has an infinite range. If there is even one deviating spacetime density, then there is also spacetime curvature. This makes it clear that spacetime curvature is always present in our universe.

3.6.4 Spacetime density of infinity

There is no compelling limit here yet. The speed of light implies that an infinite amount of energy is required to reach the low-dimensional limit. Can we get this from somewhere? A clear no. Here are three arguments:

- An infinite amount of spacetime density means that spacetime itself must be infinitely large. Spacetime density is spacetime itself. In the following sections, and especially in the chapter on cosmology, we will see that this is ruled out by the definition of the Big Bang.
- Let's leave aside the argument about the amount of spacetime density and focus only on length contraction and time dilation. We'll pretend that no external energy is required for this. We can simply increase the spacetime density by defining the geometry. Unfortunately, that doesn't work either. As soon as we exceed the dimensional constant d, our spacetime can no longer represent this and we have to use a higher-dimensional spacetime.
- What about pure geometry? The spacetime density increases for objects with rest mass up to the speed of light. However, we cannot reach this limit because it is associated with one less spatial dimension, and the existing dimension cannot simply disappear. This is also not possible for objects without rest mass. There, we obtain a representation with a wavelength. If we reach the dimensional constant again for this wavelength, we end up in a black hole.

No matter which side we come from. A single spacetime does not allow for infinite spacetime density or spacetime curvature.

3.6.5 Spacetime curvature of infinity or (no) singularity

GR is often criticized for predicting a singularity in the Big Bang or at the center of a black hole. This is only correct if one reduces the spacetime density to a point size or, in other words, does not know the limits of our spacetime. In the case of the Big Bang, this is the entire spacetime; in the case of a black hole, it is the mass of this object. In both cases, however, this is only a mathematical abstraction. Unfortunately, this circumstance is not included in the field equation of general relativity. In the Einstein tensor, spacetime curvature can be extended to infinity if a point size is assumed for the spacetime density. But then the spacetime density would have to be gone. A black hole in our spacetime always has a mass. The black hole is there, and so is the spacetime density that led to it. This means that a volume of spacetime density is always preserved at the center of a black hole.

There is no singularity in DP

The abstraction of a point has always caused problems. This is precisely where string theory comes in. Not a point, but the first mathematical "level" above the point, an object with only one spatial dimension, a string.

This gives us a very nice result for spacetime. Theoretically, spacetime density cannot have a value of zero or infinity. Theoretically, spacetime curvature cannot be infinite. Unfortunately, this is not included in the field equations. There could be a spacetime curvature of zero, but then there would be no deviating spacetime density in this spacetime, and it would therefore be "empty." Empty here means that there must be no particles. Spacetime itself carries energy even without a particle. Its existence is sufficient for this.

3.7 G, k, c, d, and h

We will take a closer look at the natural constants and Planck values used so far. Then we will add Planck's constant h so that we can define our three Planck values of length, time, and mass, which have not yet been determined, with another equation. Here we are anticipating Part 3 a little. We will discuss the Compton wavelength in a moment. We will see that the quantum of action and the Compton wavelength follow from the low-dimensional limit of our spacetime and are not determined in the low-dimensional (QM). GR dictates this behavior to QM and not vice versa.

3.7.1 The gravitational constant G

In textbooks, the three most important natural constants are always c, h, and G. In DP, we will shift this to c, h, and d. Then the gravitational constant G will no longer be relevant to us. We achieve this because G is composed of c and d. It makes sense that the gravitational constant G is generated from the boundaries of spacetime. The behavior of spacetime in the classical view with G must lie between the boundaries of spacetime. These boundaries are so far the only values determined by our spacetime.

Since G is a natural constant, it has not yet been derived. The term "natural constant" simply means that in physics, a proportionality constant is used in a formula about which we have no knowledge. No explanation for it means natural constant. We were able to derive c and d from the dimensional limits of our spacetime. If G is no longer to be a natural constant, we must be able to generate G from known (and, very importantly, derived) natural constants.

Since we are already working with Planck units, we will continue here. The gravitational constant is defined via Planck units as follows: $G = \frac{{l_P}^2 * c^3}{h}$. We will jump ahead a little and specify that we can write Planck's constant as $h = l_P * m_P * c$. This gives us $G = \frac{l_P * c^2}{m_P}$. We extend this fraction by c^2. Then we have the desired form:

$$G = \frac{l_P}{E_P} * c^4 = d * c^4$$

The gravitational constant is composed of c and d. We can also explain why c and d must be used in this way. This means we must be able to explain why d is used without an exponent and why c must have the exponent 4.

The dimensional constant d creates a black hole and thus the higher-dimensional boundary for the entire spacetime. Regardless of the spatial dimension on which the spacetime density is mapped. If d is reached on any dimension, a black hole is created for the entire spacetime. Therefore, no exponent is required.

The speed of light c is independent for each spatial dimension. The momentum in one direction does not influence the other spatial dimensions. Length contraction only occurs in the direction of motion. Therefore, a c^4 must be used to consider the entire spacetime. But the time dimension always goes along with a spatial dimension. Why not use a 3 as exponent? This is due to the structure of the field equations for GR. We will show this in the next section.

This only achieves a shift from c and G to c and d. Swap one letter and you're done. A clear no! We can derive the existence of the constants c and d based on our approach. There is no explanation for G. For us, G is simply the appropriate combination of c and d if you want to make a statement within spacetime. In the next section, we will see that the use of G in the field equation does not make sense at all.

3.7.2 Proportionality constant k in GR

Let's take another look at the field equation of GR: $G_{\mu\nu} = k * T_{\mu\nu}$

The tensors G and T contain the structure of spacetime with the respective metric as the solution to the equations. The proportionality constant k does not know any metric and should therefore not have to concern itself with the structure of spacetime. Only the boundary conditions should be included. This does not depend on the metric. This is exactly how it is. The normal description of k is structured as follows:

$$k = \frac{8 * \pi * G}{c^4}$$

We now apply our new definition to G and obtain

$$k = \frac{8 * \pi * d * c^4}{c^4} = 8 * \pi * d$$

We immediately recognize that G is not needed in the field equations. In the old description, k must be explicitly reduced by the c^4 so that G can be used there. In the metric, the time dimension is treated as a spatial dimension. The different dimensions exhibit dependent behavior as spatial dimensions only in the metric. G does not know this mutual behavior. Therefore, the c^4 in G also makes sense in this description. One c for each dimension separately.

If we eliminate G, then all limits of spacetime must still appear in the field equation. The stress-energy tensor T describes the different forms of energy. Since c is always necessary to describe energy, the low-dimensional limit is contained in T. The higher-dimensional boundary is a resistance value of spacetime independent of the distribution of spacetime density in T. Therefore, we can extract this from T and there can be a k. Only the higher-dimensional boundary can then be contained in k. This means that k is structured in line with our logic. The spacetime density generates the spacetime curvature against the resistance of spacetime.

Where does the 8π come from? If you construct the field equations mathematically, it is absolutely clear where the 8π comes from. However, the mathematical description never gives a reason and only shows how it works. We want to have a reason for everything. Here is a very simple clue:

8 * π = 4 * 2π

Can you remember the example comparing electrical and gravitational forces to motivate the idea that "everything is an object"? On the one hand, we have the ratio of forces and, on the other, the ratio of masses squared.

$$\frac{F_{Elekt} * 2 * \pi}{F_{Grav} * \alpha} = \left(\frac{m_P}{m_e}\right)^2$$

A ratio of mass cannot directly be a ratio of forces. These are two very different perspectives on the same object. We need something like a conversion from one perspective to the other. In the example, this is 2π and α. With α, the conversion is needed for each interaction. With 2π, it is needed for each spatial dimension. The gravity between two mass points is considered a 1-dimensional connection. If we consider the entire spacetime in the field equation, we need this 4 times. When converting from the perspective of spacetime force to the perspective of gravity, 2π is probably always required for each spatial dimension. The dimensional constant d is a reciprocal value of the force. This makes the structure of k identical to our force comparison.

I have not yet been able to determine the reason behind this with 100% certainty. Currently, in 2026, everything boils down to the following explanation. The trigger for spacetime curvature must lie in our spacetime. However, the spacetime density in a black hole lies behind the event horizon. The event horizon is decisive for energy. It cannot escape from there. A geometry in our spacetime therefore does not follow a straight line to the center of the black hole, but around it. This means that 2π always comes into play in the circumference of a circle. This gives us our first point of uncertainty in the DP. Fortunately, there are only a few more. This is one of the strengths of the DP.

3.7.3 Planck's quantum of action h

Let's complete our trio of explainable natural constants. We still need h. Do we even need h? We were able to generate G from c and d. We know the value of G. Then we have three equations with three unknowns. We can use them to determine the Planck values. From a physical point of view, however, we do not obtain any new information about spacetime from G. The gravitational constant is only a composition of known things. We need an additional condition from the spacetime boundary.

As the name suggests, h is a quantum of action. Let's first ignore the part with "quantum" and concentrate on the "action." Action means change. From one fixed state to another fixed state. Action describes a change of state. The state that we can perceive is always some form of energy, i.e., spacetime density. It is about the change in state of spacetime density. The higher-dimensional limit results from the description of GR with spacetime curvature. But the "quantum" part is certainly not included in this. No one has yet succeeded in quantizing spacetime curvature. So, let's look at the combination of spacetime density and low-dimensional boundary. This topic will be covered in Part 3 and the description of the entire QM. Here we only consider the direct transition into our spacetime. GR describes the behavior **in** our spacetime with the boundaries, but not outside of spacetime.

3.7.3.1 Definition of h

We want to describe an effect from the low-dimensional boundary into our spacetime. Where do we start? Exactly, with a length. In DP, we only have spacetime density, and so everything must be mapped to a spatial dimension. We always need a length.

Step 1: $h = l_P$

Since we want to have an effect from the low-dimensional space, the boundary condition must be fulfilled. We need exactly one speed of light. Here, however, it is multiplicative and not a fraction. We want to create an effect. We can only reach our spacetime once via this boundary. The time dimension is already set to zero when a single spatial dimension is missing. This cannot be done again within spacetime. Therefore, c must not have an exponent.

Step 2: $h = l_P * c$

Then we still need something with which to act on the spatial dimension. We don't have many choices in DP. It must be a form of spacetime density. It cannot be direct energy, i.e., the spacetime density in our spacetime. Here we are anticipating a later section. No time passes beyond this boundary (time definition set to zero = boundary condition), since the time dimension is always bound to the respective spacetime configuration. Let's take another look at the definition of energy.

$$\boldsymbol{E = \sqrt{m^2c^4 + p^2c^2}}$$

The second term cannot be it. An impulse is the increase of a given spacetime density in 3D, in one direction. This part is precisely the spacetime density in our spacetime and therefore cannot originate from a lower-dimensional spacetime. With a movement within our spacetime, we do not get very far in describing the boundary. The movement is already covered by c from step 2. So, the first term. But there is still a c there. The c is the crossing of this boundary and is already included in step 2. We have to use energy without c. This actually clarifies what mass is. A representation of a spacetime density from an n-dimensional spacetime in an (n+1)-dimensional spacetime. It is therefore not surprising that spacetime boundaries always play a role in describing the energy of a mass. We will do this more precisely in a later section. The important thing here is that we can only use the rest mass. Energy without temporal reference.

Step 3: $\boldsymbol{h = l_P * m_P * c}$

Done! The effect from a lower-dimensional spacetime on our spacetime can only look like this. Okay, but what about the "quant" part? It could be a mapping to any length, any other speed, or any other mass. Why use the Planck values of our spacetime if the effect comes from the lower-dimensional one? In particular, we said earlier that in the lower-dimensional one, the Planck masses are explicitly different from those in our spacetime.

3.7.3.2 Quantization

The limits come from GR. This describes only one spacetime, our spacetime. When we measure anything through an interaction or receive information, this happens only and exclusively in our spacetime. Energy is the spacetime density of our spacetime. Especially in, we are still at the stage where we can only recognize the spacetime density and spacetime curvature of our spacetime.

This means that any effect on a spacetime density is a change in the spacetime density in our spacetime. Thus, an effect must comply with the conditions of our spacetime, regardless of the low-dimensional spacetime configuration from which this effect originates. This is h between the boundaries c and d with the known Planck values of our spacetime. This is the structure of our spacetime. As silly as this statement may sound, the quantization of all effects does not come from QM, but from the low-dimensional boundary of our continuous spacetime.

Quantization by h results from the characteristic Planck values of our spacetime through the low-dimensional boundary.

To round this off, let's move on to the next section and take a look at the Compton wavelength.

3.7.4 The Compton wavelength

Why are we including the Compton wavelength here? Isn't this a prime example of quantum mechanics? Because we need a state in addition to an effect. Unfortunately, this fact is well hidden in textbook descriptions.

The term is often referred to as the Compton effect or Compton scattering. A photon is fired at a particle with rest mass. That sounds very much like a process and not a state. The appropriate formula: $\Delta\lambda = \frac{h}{m_C * c}(1 - cos\varphi)$. The formula describes the increase in the wavelength of the photon due to scattering. What is striking is that the state of the photon before the process is not included in the formula. Only the angle is decisive. Let's make life easy and assume an angle of 90° for the scattering. Then the cosine is zero. The formula is simplified, and we obtain a characteristic wavelength for a mass, the Compton wavelength: $\lambda_C = \frac{h}{m_C * c}$. This looks much simpler. The subscript C denotes the particles involved in the scattering. The equation also contains an h. This is a poor representation. The formula describes the result after the process and is therefore a description of a state.

Let's take our new definition of h and insert it into the formula:

$$\lambda_C = \frac{h}{m_C * c} = \frac{l_P * m_P * c}{m_C * c} = \frac{l_P * m_P}{m_C} \Rightarrow \lambda_C * m_C = l_P * m_P$$

To make it look a little nicer, we rename λ_C to l_C.

$$\boldsymbol{l_C * m_C = l_P * m_P}$$

This is a good result. Let's take a look at what this formula tells us:

- The Compton wavelength is the description of a state after scattering and not a description of a process. There must be no h (action) on the right-hand side. We have a state. Therefore, the c for the speed of light must be removed from the formula. The c is the boundary transition for the action. In a state in our spacetime, the c is not needed.
- On the right-hand side, you see h without c ($h = l_P * m_P * c$). This formula must be valid for every object in our spacetime. We have not made any restrictions. It follows that there is only one unique state in our spacetime. In our spacetime, only $\boldsymbol{l_P * m_P}$ is allowed as a state for objects.
- The "internal" structure of an object (QM) can be divided differently on $\boldsymbol{l_C * m_C}$.
- Our continuous space-time has no condition for quantization. This only comes from the boundaries. Since the effect is always bound to h, only states in this increment can occur. Our continuous spacetime does not explicitly specify this. It only comes from the transition of the boundary condition.

Anyone who was surprised that we can generate quantization from GRT will now have to grit their teeth. We're going to take it up a notch. Take a deep breath and let's go.

- In our spacetime, due to the boundaries of spacetime, not only are all effects from the low-dimensional quantized, but there is also only a single recognizable state for a single spacetime density $\boldsymbol{l_P * m_P}$ when the low-dimensional boundary was involved.
- QM describes all possible "internal" mappings in low-dimensional spacetimes of this spacetime density and possible interactions between these low-dimensional mappings in our spacetime. These low-dimensional spacetimes (fields of QFT) themselves do not know any quantization. The only condition for quantization remains the low-dimensional boundary.

- No single spacetime knows quantization for itself. Only the dimensional transition between spacetimes with different numbers of spatial dimensions produces a quantized effect and a single recognizable state per spacetime.

The state of a single spacetime density is fixed at $\boldsymbol{l_P} * \boldsymbol{m_P}$. The change with an h is just a different distribution on the side with the internal structure $\boldsymbol{l_C} * \boldsymbol{m_C}$. That is why h is attributed to QM. However, the definition comes from the boundary of our spacetime.

That was strong stuff, but two important properties from the boundary of spacetime are still missing. We will deal with these topics first and then return to rest mass.

3.8 Recognizable geometries across a dimensional boundary

In the logic presented so far, it is not 100% clear why we can recognize interface objects in our space-time. The following question arises: What properties can we recognize across a dimensional boundary? We are certain that we must be able to recognize something. In our spacetime, there are photons as objects for the lower-dimensional boundary and black holes as objects for the higher-dimensional boundary.

We will see that we can only preserve very few properties across the dimensional boundary. This runs counter to normal intuition. There are two major areas here. We will treat time as a separate area in the next section, 3.9. Here, we will deal with the geometry of objects and thus with the geometry of spacetime.

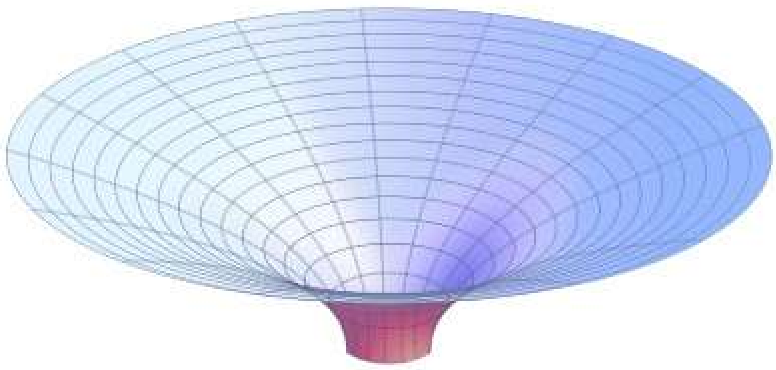
3.8.1 Higher-dimensional boundary

The idea that a black hole is some kind of transition is old hat. There are lots of different ideas about this. One of them, for example, is the keyword: wormhole. If you don't look at it too strictly, the higher-dimensional transition just looks like a wormhole. In DP, into a higher-dimensional spacetime. With the ingredients black hole and transition, it's very easy to come up with this idea. Unfortunately, the wormhole doesn't fit. To put it bluntly, the idea of a wormhole is completely wrong.

3.8.1.1 Transition via density or curvature

The problem is graphics of this kind

Figure1: Flamm's paraboloid / Source reference: Wikipedia 2025 Mrmw - Own work, based on: Lorentzian Wormhole.svg:



A spacetime curvature from our 3D spacetime is reduced to an image in a 1D spacetime (one spatial component radial and one temporal component diagonal). Mathematically, everything is neat with one restriction. GR does not need a higher-dimensional surrounding space for spacetime curvature. The image shows the 1D spacetime curvature explicitly with an extrinsic manifestation in 3D. According to GR, this is incorrect. However, it cannot be represented in any other way. Such an image of spacetime as a funnel is called a wormhole. The decisive factor is the "bottom" of the funnel. Where does the "hole" lead? This is precisely where the problem lies. There is no hole.

The image with the funnel leads one to believe that a wormhole is created by the curvature of spacetime. This is also the general textbook opinion in physics. Here, from the DP, a clear no! The curvature of spacetime has nothing, absolutely nothing, to do with the transition. The funnel image leads us down the wrong path. The condition for the transition is: $d = \frac{l_P}{E_P}$. It mentions length and spacetime density. There is no mention of spacetime curvature. Spacetime curvature is the compensation of spacetime to a spacetime density. The transition is the spacetime density and not the spacetime curvature. Okay, the transition is at the bottom of the funnel and the spacetime curvature leads there. However, spacetime curvature is not the transition. There is no singularity of spacetime curvature. In this representation, the bottom must simply be a flat disc. Spacetime curvature only extends to spacetime density. This means that the bottom is flat. It is precisely this flat bottom without spacetime curvature that must be connected to a higher spacetime.

The space-time density, and not the space-time curvature, is the reason for

the higher-dimensional transition

Cross-check: If the transition lies in the spacetime curvature, then there would have to be a maximum value or a singularity for the spacetime curvature. With singularity, we have an infinite value, which cannot be a transition; it is not defined. If we have a maximum value, then the growth of a black hole would have to be limited. The spacetime curvature would then only reach this value. No more matter could fall into the black hole. There is no known growth limit for a black hole.

3.8.1.2 4D to 3D

What can we recognize in a spacetime density that also lies in 4D? These can only be the properties from our spacetime that are connected via the transition. In the case of spacetime density, this is not much. We only recognize the properties of energy. Let's take another look at the formula for energy:

$$\boldsymbol{E = \sqrt{m^2c^4 + p^2c^2}}$$

The first term is then the rest mass of the black hole. The second term is the motion of the black hole in our spacetime. There is momentum and angular momentum. That's it, that's all we have.

3.8.1.3 Information paradox

Wait a minute! We are familiar with this topic. In addition to mass and intrinsic motion, a black hole also has at least one property: electric charge. The charges cannot simply disappear. This leads us directly to the information paradox of a black hole.

The first limitation on the contents of a black hole comes from the curvature of spacetime. We agree with QM that all interactions of the Standard Model without gravity can only be transmitted via exchange particles. The fastest of these is the photon. A black hole is characterized by the fact that even a photon cannot leave the event horizon. This means that no single property from QM can be known outside the event horizon.

In quantum mechanics, it is a mathematical theorem that information cannot simply disappear. Since we do not change the mathematics of quantum mechanics, but rather confirm it, we must adhere to this theorem. The fact that we humans outside the black hole can no longer access this information is not a paradox, but merely our own arrogance. This is not important.

The problem lies, for example, in Hawking radiation. The exact mechanism is not relevant here. What is important is that a black hole can release its energy through particles that were not behind the event horizon at all. The particles from the edge of the event horizon therefore do not carry any information out of the black hole. Nevertheless, the black hole loses mass and dissolves very, very slowly. Where has the information of the particles in the black hole gone?

The information is indeed no longer present at the "bottom" of the funnel. Nevertheless, we are not violating the information theorem. You can probably guess the reason. The dimensional transition. The low-dimensional transition between 3D and 2D generates the entire QM. Only at the center of a black hole are we at the transition from 3D to 4D.

The condition for a black hole is: $d = \frac{l_P}{E_P}$

The condition for a mapping across the low-dimensional boundary is:

Effect: $h = l_P * m_P * c$

State: $l_C * m_C = l_P * m_P$

The condition in d is explicitly such that we either have a length smaller than l_P or energy with a mass greater than m_P. Then we can map neither an effect nor a state in our spacetime via the low-dimensional interface. This fits very well, since the condition for a black hole is that the spacetime density can no longer be mapped in our spacetime. Then we can no longer obtain a 2D mapping for it either.

That makes perfect sense. QM is formed via the interface between 2D and 3D. In a black hole, however, we are outside of spacetime, or rather, right on the border to 4D. There is no longer a 2D representation. With the formation of a black hole, the 3D spacetime density loses its 2D representation for QM. QM is no longer applicable there and cannot make any statements about the higher-dimensional transition. There is no information paradox from QM in a black hole. QM loses its validity at the center of a black hole. There is actually no low-dimensional "inner" structure of spacetime density in a black hole. Therefore, there is no information. QM does not lose any information for itself; it is simply no longer meaningful there. In fact, the opposite is true. If Hawking radiation from a black hole were to bring out its information, then we would have a problem.

Perhaps you can guess how I feel when, time and again, the great promise is made that only QM with some kind of quantum gravity can solve the mystery of the singularity in a black hole, **lol**.

3.8.2 Low-dimensional boundary

The exact description of the interface is the entire Part 3 of QM. Here we will only address one point. If everything is a deformation of spacetime due to density and curvature, why can't we recognize this geometry directly from the low-dimensional? We are not saying that an elementary particle has a spacetime curvature upwards or downwards. New terms such as spin and charge are added. This suggests that it is not so easy to recognize a spacetime geometry via a dimensional transition.

The whole thing is even wilder than that. In a first approach, it is impossible to recognize any geometry at all across such a boundary. That point was almost the end of DP. It was clear that this transition would be one of the most important properties of DP. However, for a very long time, I was unable to find a geometric mapping across the boundary. In retrospect, the solution was so simple and obvious that I was really ashamed of myself. Once you have the solution, everything is very easy. But first you have to come up with it. The solution is the interface itself. From that point on, almost all other problems solved themselves. All it took was a little time and brainpower.

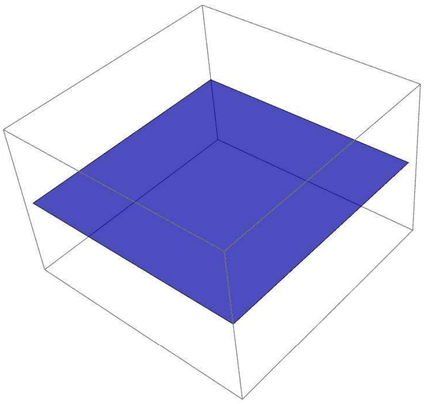
3.8.2.1 Nothing works anymore

The real problem is not a low-dimensional transition, but fundamentally the transition with a different number of spatial dimensions. The problem exists in every n-dimensional spacetime.

Let's start in our spacetime and imagine a volume. Length * width * height. The volume has an extension and a surface area in our spacetime. So far, so good. Now let's take a two-dimensional surface with length * width and height = 0. One spatial dimension must be zero. That is the definition of low-dimensional. Then, by definition, the volume and surface area are also zero.

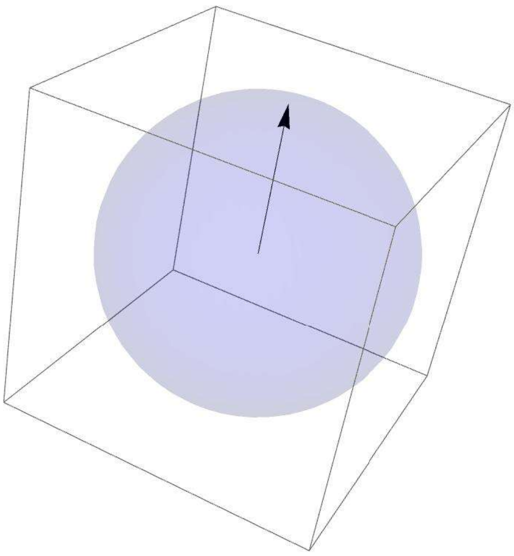
But we can specify the length, width, and area for the surface. These are good dimensions. Yes, but that is again a mathematical abstraction, similar to the discussion with the point, this time in 2D. In 3D, we cannot recognize the beginning or end of length or width. The height is zero. For us as 3D beings, there is nothing there. A 2D surface can be described mathematically in abstract terms, but it cannot be recognized in real 3D spacetime. We are no better off if we turn the surface into a sphere (a closed object). This is because the height or thickness of the surface that bounds the sphere is zero by definition. There is nothing there.

Figure2: Simple 2D surface



How can we recognize the surface as an object in 3D if we cannot determine the beginning or end of its length or width due to its lack of height?

Figure3: 2D sphere as a supposed 3D object



At first glance, this looks like a 3D object. But to do so, we would need to be able to determine the shell with the radius. However, the height of the shell is defined as zero. There is nothing where we can determine a radius. This means that we cannot identify this supposed 3D object in our spacetime.

We can "crumple" a surface such as a sheet of paper as we wish. The sheet of paper has a volume. Therefore, we can recognize any change in its shape. A surface has no volume and no surface area. Therefore, we cannot recognize this surface in any form.

Everyone needs to think about this separately in a quiet moment. You will come to the following conclusion:

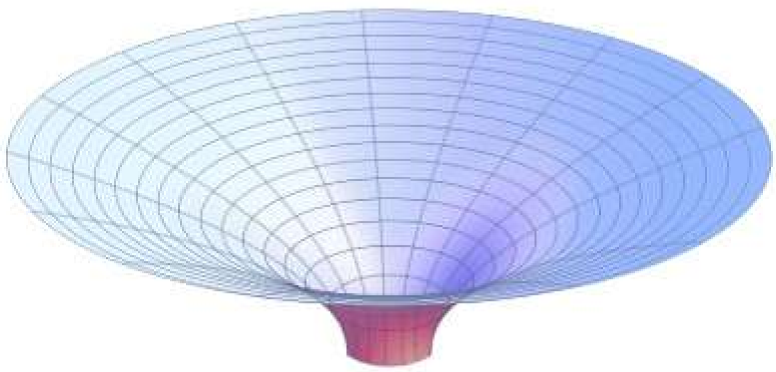
No geometric quantity can be transmitted across the dimensional boundary.

Length, volume, surface area, or even just a distance are specifications that only correspond to meaningful geometric specifications in their own n-dimensional spacetime. It does not matter what form the lower- or higher-dimensional geometry has. This geometry is not recognizable in its own spacetime. That is very little. In Part 3, we will see that it is precisely this behavior and the lack of time from Section 3.9 that make the description of QM so "strange."

We should be able to recognize something, otherwise our approach is wrong. However, it is not necessary to be able to recognize geometric shapes. We must be able to recognize a spacetime density. Everything is based on this.

3.8.2.2 The problem is the solution, first: extrinsic manifestation

In the textbook description of GR, spacetime curvature and thus also spacetime density are always intrinsic to spacetime. Let's take our funnel image, Figure 3-1. It is important to note that, from a purely mathematical point of view, the image is a 100% accurate representation. Only from the perspective of GR can there be no extrinsic curvature.



This means that the spacetime curvature must lie in the plane. In the funnel, however, the spacetime curvature is explicitly drawn downwards out of the plane. This makes it an extrinsic representation and actually incorrect for GR. Really? Why does GR not want to have an extrinsic representation? This is precisely where the solution lies.

Our 3D spacetime would have to be embedded in a higher spacetime. Since we want to get by with as few additional assumptions as possible, we leave this out and make the illustrations intrinsic. This is not a problem mathematically. However, the description of GR could just as well be extrinsic. This is the application of Ockham's razor.

Fortunately, we are in the description of the DP. The spacetime boundaries necessarily imply that our spacetime is embedded in at least one higher-dimensional spacetime, since we have black holes. The spacetime boundaries exist. It follows that we can use an extrinsic description without restriction. In Part 3, we will see that, with one exception, the rest mass, we can only recognize extrinsic properties.

Here is a false image of a 2D surface in a 3D volume. There can be as much 2D geometry in the 2D surface as you like. We cannot recognize anything. The surface is only an abstraction.

Figure5: Simple 2D surface

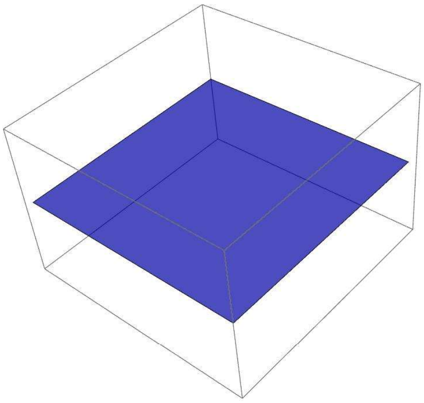
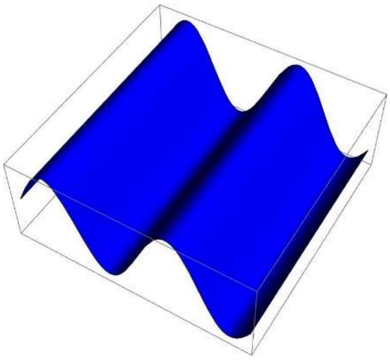


Figure4: Wavy 2D surface



However, if we extrinsically deform the 2D surface into a wave, then the 3D volume contains more 2D spacetime. This is an increase in spacetime density in the 3D volume. There is more low-dimensional spacetime contained. This means that if we deviate from the default setting of not using extrinsic deformation, we have found a way to achieve a recognizable spacetime density.

The dimensional interface, which does not transfer any geometric properties, also means that we can use an extrinsic characteristic due to the embedding. We can recognize this characteristic in 3D. A wave representation cannot be recognized in 2D itself. It must always go through the spacetime density. This means that a photon (a representation in only two spatial dimensions) must necessarily be a wave representation. However, it is a wave representation of a single spacetime density. Particle and wave at the same time. This is not an error or a paradox; it is actually correct in this simple image. This also allows us to explain why the wavelength and not the amplitude indicates the energy for a photon. If we increase the amplitude, we would also have to increase the volume affected. The amplitude becomes larger and the height of the volume grows identically. This does not give us a greater spacetime density in a volume. Only when we push the wave crests together do we obtain more 2D area in the same volume. This is completely independent of the amplitude.

Figure7: Wave with an amplitude of 1

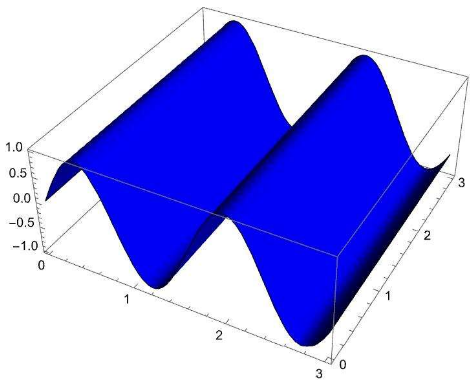


Figure6: Wave with an amplitude of 4. The ratio of wave to volume remains the same.

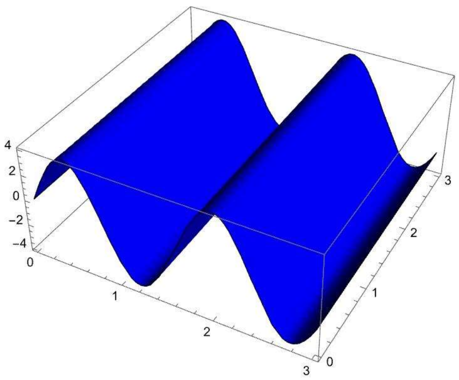
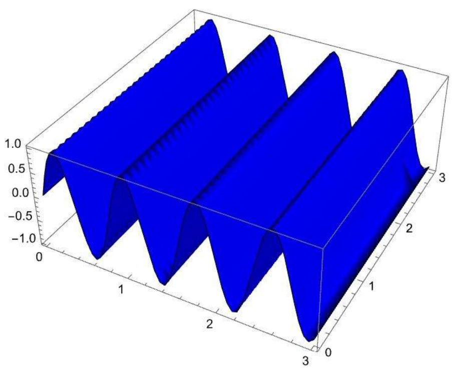


Figure8: More 2D wave in 3D volume due to shorter wavelength.



This is a very simple image (and to be precise, an incorrect image) of a photon, but we will discuss this in more detail in Part 3. The waves are traveling in the wrong direction here! The spatial dimension in the direction of the amplitude is missing. The photon would then have to move in this direction. However, this is suitable for illustrating an analogy. We have now found a possible transition for the representation of spacetime density in 3D.

3.8.2.3 The problem is the solution, part two: black holes

Wave mapping sounds as if it is heading in the right direction for QM. For QM, we have to map the entire particle zoo of the Standard Model in low-dimensional spacetime configurations. The possibility of extrinsic mapping is a start. However, it is never sufficient for the required diversity. It's good to know that something is still missing. But what is it? We have already looked at the solution twice and discussed it.

Drum roll, the solution is: the funnel. I won't show the picture here, otherwise it wouldn't be a surprise. The funnel in connection with the spacetime boundaries gave us the idea that we could use an extrinsic representation such as the funnel. Question: What object should the funnel represent? Exactly, a black hole. What is a black hole? Right, the higher-dimensional transition. We need a representation of a black hole in the lower dimension. Then we have a higher-dimensional transition from 2D to 3D and are exactly where we want to be, in our spacetime. It's written here in this paragraph so simply. Believe me, this simple idea was a difficult birth.

This black hole is also the reason for particles with rest mass. The funny thing is that there is a small calculation about a black hole in quite a few textbooks. Please calculate why an electron cannot be a black hole. The calculation is simple and results in a Schwarzschild radius of approximately $1.353 * 10^{-57}$ for the electron. This is smaller than the Planck length. Therefore, an electron cannot be a black hole. We will see later that this statement is absolutely correct for our spacetime. There is a minimum limit for the Schwarzschild radius. The electron falls short of this by many orders of magnitude. However, the electron is the perfect black hole in a 2D spacetime. With a much smaller dimensional constant than in this spacetime. Every spacetime has its own Planck values. We already know the Planck mass of a simple 2D spacetime, the rest mass of the electron.

3.9 Time

The mystery of time certainly deserves more than just one section in this chapter. We can be sure that we will not solve it completely. However, we need a suitable logical description of time for the DP. This is discussed here because in the DP, time can only be understood in connection with the spacetime boundary.

Time is always associated with change. Without change, time could not be recognized, and vice versa. In DP, everything we can recognize is associated with at least one spatial dimension. To be able to map a density, we need at least one spatial dimension. A change in a mapping is therefore always a change in spatial dimension and time. Time and space are therefore not independent.

We have already started with an approach from GR. It is therefore clear that we must work with spacetime as an inseparable object. Nevertheless, it makes sense to derive this unity as a consequence of a density on the spatial dimension. Since space and time are not independent, we will stick with spacetime and spacetime density.

However, the question remains as to why time does not simply pass at a constant rate when the density of space changes. This is because a change in the density of space is a change in the definition of space. Speed is length divided by time. Time remains the same, but length becomes "shorter" when acceleration occurs. The object would slow down during acceleration. This does not correspond to observation. The calculations of GR only work because the time dimension has been turned into a spatial dimension. Again: in GR, as in SR, the time dimension is a spatial dimension with different signs. The definition of geometry changes in the spatial dimension. This means that the time dimension, as the definition of time, must also change. The spatial and time dimensions change the definition of what a unit of length or a unit of time is. Nothing is squeezed or stretched.

Time is thus bound to the spacetime configuration. If this configuration changes, for example, if there is one less spatial dimension, then this is no longer the same spacetime. The object spacetime is abandoned. Then time must also run towards zero. Therefore, each spacetime configuration must have its own time dimension.

From this, we can deduce the following:

- The time of a spacetime cannot extend beyond the dimensional boundary.
- Each separately existing spacetime configuration has its own time dimension that is bound only to this spacetime. The time dimension is not only dynamic, it is also local to each spacetime. Therefore, we do not count the time dimension in the number of spatial dimensions. There is always an additional time dimension. We also count only one human being and not one human being and one head. It is always there.
- The dimensional transition only applies to the spatial dimensions, but never to the time dimension

From the perspective of time, the spacetime boundaries are reached when we can no longer achieve any effect on a state, no further change. Then we can no longer determine time. Let's take another look at the small formulas for effect and state in our spacetime:

Effect: $h = l_P * m_P * c$

State: $l_C * m_C = l_P * m_P$

Let's take only the right side in each case and put the effect in relation to the state:

$$\frac{State}{Effect} = \frac{l_P * m_P}{l_P * m_P * c} = \frac{1}{c}$$

This is the "resistance value" of spacetime against change. It is bridged at c and no further change can occur. The effect from the lower dimension must still be able to change the state mapping from the lower dimension. This is the lower-dimensional boundary.

From these considerations, we can equate time with the distance to the boundaries of spacetime.

Time is a measure of distance to the spacetime boundary

Thus, in DP, there is no flow of time or arrow of time. The better view is that the experience of time is the constant measurement of distance to the spacetime boundary. Therefore, we do not experience the past. The next measurement to the boundary always comes. The "measured value (the definition of the unit of time)" can repeat itself from the past. However, it is a different measurement. The flow of time is the series of distance measurements.

Finally, a frequently asked question: Why is there only one time dimension? This question can be easily explained with our new perspective. The object spacetime can be left exactly once. Then you are out. We cannot leave spacetime again once we are already outside. Therefore, there can only be one time dimension. The passage of time is the distance measurement to the spacetime boundary. Only one time dimension per spacetime is possible.

The idea that time is a distance measurement has another reason: the principle of relativity. This explains very well why time remains constant locally. This will be worked through in the next chapter.

3.10 Rest mass and E = mc^2

There are separate values for each elementary particle for rest mass, unlike h, which has one value for all. Of course, h comes from the interface and simply applies to everything from the low-dimensional. Rest mass is a low-dimensional spacetime density. Rest masses are also a quantum in themselves. For each particle/spacetime configuration, there is only one specific value and then a multiple of that.

Each spacetime configuration has its own Planck values, and in 2D, every image we perceive in 3D with rest mass is an image with at least one black hole. The rest mass for an electron in 2D is the Planck mass for the dimensional constant there. The rest mass is the energy or spacetime density without the temporal component.

Let's look at this with some mathematics. For the rest mass, we can again use the most famous formula in the world: $E = mc^2$. If we want to turn the rest mass into energy in our spacetime, we always have to insert a c^2. Why is that? I hope that no one will now come up with the idea that "well, the formula specifies this." Yes, the formula does, and the units of measurement must match. We have to explain why we use c^2 based on the logic of DP. As always, this results from the interface. The superposition of 3D to 2D is only in space. This means that in the first step, we have only occupied two spatial dimensions. Since the dimensional constant was exceeded in 2D, more spatial dimensions are required for the mapping. However, energy and thus spacetime density in our spacetime must occupy all three spatial dimensions and the time dimension. The transition is always one spatial dimension and one time dimension. The time dimension is a "disguised" spatial dimension. Since we have to create the "transition" for this, we need one c per spatial dimension and end up with c^2. So, we always have to multiply by a c^2. The logic is correct for spacetime of any dimension, since we only ever create the transition to a spatial dimension higher n+1 or lower n-1. Even with one spatial dimension, we can more or less no longer recognize any properties. With two more spatial dimensions, we can no longer recognize anything at all. With two fewer spatial dimensions, it is only possible via a detour, which we will use for neutrinos. Therefore, $E = mc^2$ is universally valid for all arbitrary spacetimes.

A word about the units of measurement for energy, force, and effect. First, let's write down the units of measurement for the three values:

- Energy: $[kg * \frac{m}{s} * \frac{m}{s}]$
- Force: $[kg * \frac{m}{s^2}]$
- Effect: $[kg * m * \frac{m}{s}]$

The way we write the units of measurement alone indicates a certain direction in which to read them. We have just clarified energy, and that is why the units of measurement look like this. We could also have written energy as follows: $[kg * \ m * \frac{m}{s^2}]$. Then it looks as if energy involves acceleration and thus a perpetual rate of change. This is somewhat strange for a quantity that cannot change itself. With our logic, the interpretation of the units of measurement is fixed. With force, something is explicitly changed. When specifying force, the change is given as acceleration, i.e., as a rate of change. With effect, the units of measurement arise because it is actually energy * time, and therefore the time in the denominator of cancels out. In other words, a continuous portion of energy over a period of time. There must be no acceleration. It is the change from one state to a new state. Since the rest mass cannot change, it is always a change in momentum. The effect therefore also includes momentum: $[kg * \frac{m}{s}]$. How this momentum is distributed over a length is then the effect. If the momentum is distributed over a short length, then the effect is large, and vice versa. We want to explain everything here. We cannot afford to use the normal procedure in physics, where we set G (at and d), h, and c to 1 and then adjust everything later in the result so that the units of measurement are correct. This only works when calculating without thinking, but not when explaining.

Can we calculate the Planck values in a spacetime configuration? Yes and no. Without a further assumption for the calculation, we will not get anywhere. The Planck values per spacetime configuration are simply given. In 2026, I have not yet found a way to calculate them. However, we can perform a calculation by anticipating a later topic. The anticipation is that we will consider electromagnetic force as low-dimensional gravity. In addition, it should be noted once again that we can only determine a rest mass from 2D in our 3D spacetime with the values known to us. In 2D itself, this looks different again.

Let's take something we know: the comparison of the forces of gravity and the electric field. I'll write down the solution.

$$\frac{F_{Elek}}{F_{Grav}} = \frac{\frac{e^2}{4 * \pi * \varepsilon_0 * r^2}}{\frac{G * m_1 * m_2}{r^2}} = \frac{e^2}{4 * \pi * \varepsilon_0 * G * {m_e}^2} = 4 * 10^{42} = \left(\frac{1}{2 * \pi}\right) * \alpha * \left(\frac{m_P}{m_e}\right)^2$$

The terms on the right-hand side do not include gravity or an electric field. Nevertheless, the values are identical. How is that possible? Assuming that gravity as a force and the electric field as a force differ only in the number of dimensions, this comparison should only depend on the difference in the Planck values and the low-dimensional transition. This is exactly what we see here.

The mathematical explanation is very simple. Let's take the term in the middle:

$$\frac{e^2}{4 * \pi * \varepsilon_0 * G * {m_e}^2}$$

Step 1: We write our definition of G into the formula.

$$\frac{e^2 * m_P}{4 * \pi * \varepsilon_0 * l_P * c^2 * {m_e}^2}$$

Step 2: We expand the fraction with a Planck mass m_P.

$$\frac{e^2 * {m_P}^2}{4 * \pi * \varepsilon_0 * l_P * c^2 * m_P * {m_e}^2} = \frac{e^2}{4 * \pi * \varepsilon_0 * l_P * c^2 * m_P} * \left(\frac{m_P}{m_e}\right)^2$$

Step 3: We pull the c^2 apart and take a closer look at the denominator.

$$\frac{e^2}{4 * \pi * \varepsilon_0 * l_P * c * c * m_P} * \left(\frac{m_P}{m_e}\right)^2$$

Step 4: There is now an $h = l_P * m_P * c$ hidden in the denominator.

$$\frac{e^2}{4 * \pi * \varepsilon_0 * h * c} * \left(\frac{m_P}{m_e}\right)^2$$

Step 5: Then the first term is almost the fine structure constant α. However, we have an h and no ħ . Therefore, we must expand the whole thing with $2 * \pi$.

$$\frac{1}{2 * \pi} * \frac{e^2}{4 * \pi * \varepsilon_0 * \hbar * c} * \left(\frac{m_P}{m_e}\right)^2 = \left(\frac{1}{2 * \pi}\right) * \alpha * \left(\frac{m_P}{m_e}\right)^2$$

These were all very simple mathematical transformations. If we want to know what this means, we have to stop calculating and move on to an explanation.

Let's roll up the field from the back and start with the term $\left(\frac{m_P}{m_e}\right)^2$. The square arises because, when comparing forces, we compare the force between two objects in the respective spacetime. Therefore, we have to put a square here. Why is the Planck mass in the numerator and the rest mass of the electron in the denominator? When comparing forces, we did the opposite. When comparing forces, the force from the electric field is much greater because electrons are much more easily influenced in their spacetime. If we apply the ratio to spacetime itself, then of course our spacetime is much stronger/tougher than 2D spacetime. Therefore, the ratio must be reversed.

We capture the fine structure constant α because we are comparing forces to the electric field. The exact explanation will come in part 3. Here is the short version: α behaves like a scale adjustment on a map. The scale must simply be shortened by α. Since the Planck mass is fixed, α can only refer to the speed of light. Since the speed of light does not depend on the number of spatial dimensions, length contraction and time dilation only affect the direction of motion without taking the remaining spatial dimensions into account, so the fraction from $\frac{l_P}{t_P}$ must be achieved with values that differ from α. The speed of light is a fraction and can be achieved with an infinite number of values. However, since the speed of light c is the dimensional transition, α must play a role in every interaction with an electric charge. In the case of multiple interactions, this occurs with an exponent. We will take a closer look at this in Part 3.

$2 * \pi$ is an old acquaintance of ours from the field equation. When we work with a force in our space-time, we need it for each spatial dimension. Since we always have a connecting line between the objects in a force, $2 * \pi$ only occurs once here. Since we have reversed the ratio, we need them in the denominator here.

That was a lengthy section on rest mass, units of measurement, and the "toughness" of the spacetime configuration. These small notes serve to better understand the topic of dimensional transition. At the end of the chapter, let's turn to a completely different topic.

3.11 Limits of spacetime and other theories

In the last section, let's look at a specific effect of the boundaries of spacetime. If there is any truth to the idea of a very hard boundary of spacetime, most other "Theories of Everything (ToE)" or interpretations of quantum mechanics have a big problem. Almost all of them no longer work.

We can divide the mainstream approaches to these theories into four categories:

- Quantization of spacetime: Attempts are made to describe spacetime not as continuous, but divided into quanta. The best-known representative of this approach is loop quantum gravity.
- Quantization of gravity: Spacetime could remain continuous, but gravity, like all other interactions, should be described by exchange particles. The keyword here is quantum gravity.
- Multi-dimensional approach with separate spacetimes: Here, completely new worlds are created in QM in terms of probabilities. Each probability actually exists in a separate spacetime/universe. This is where the buzzword "many-worlds interpretation" comes into play, with the best-known candidates being the Everett or EWG interpretation.
- Multi-dimensional approach with a single spacetime: The properties required to describe our universe are placed in different spatial dimensions, but all in a common spacetime. The best-known representative here is clearly string theory.

There is no single theory in the four categories. There are always whole families of different theories. How many different family members there are is not relevant to us. In DP, we can find an argument for each of these categories as to why this cannot work. This makes it clear how popular DP is among physicists. We can probably rule out over 95% of all approaches for which these physicists receive research grants in this field. Here, we have to grin and bear it. This is not about labeling other theories as "bad." If we can rule out these theories, then we have found tests for DP. The fundamental characteristics of these theories are tough tests for the DP. Let's just go through the categories.

3.11.1 Quantization of spacetime

Here we have two killer arguments as to why this can no longer work. In the DP, energy is also the state of motion. This means that spacetime must have two compelling properties: it must be continuous and differentiable. Otherwise, we cannot map motion as spacetime geometry directly in spacetime. A spacetime in quanta is therefore not possible. In particular, in all other theories, spacetime and the content of spacetime are separate descriptions. Spacetime is only used as a "background." Then one could still imagine quantization. But if motion is a geometry of spacetime itself, this no longer works.

The second argument is the boundary itself as we have defined it in DP. This can only be the speed of light and a black hole. How can spacetime, usually on the length of Planck scales, be divisible into pieces? Then every spacetime quantum either travels at the speed of light and can no longer determine time, or it is a black hole. We can confidently rule out both variants. Quantization of spacetime is not possible with the DP approach.

What we do with the boundary of spacetime is that we separate complete spacetimes very strictly from one another. For us, a single spacetime is a piece/object. However, we cannot further divide a single spacetime.

If quantization of spacetime is ever detected, the DP will be falsified.

3.11.2 Quantization of Gravity

Here we must anticipate somewhat in the areas of cosmology and QM. We will find there that exchange particles can only exist between spacetimes that are embedded in at least one higher-dimensional spacetime. Exchange particles, in turn, can only be images in an embedded spacetime. Spacetime curvature is explicitly a description in its own spacetime. The spacetime curvature does not change the spacetime density. This means that there is also no change in the lower-dimensional images. We do not obtain an image of the spacetime curvature across a spacetime boundary. As a reminder, the transition always lies in the spacetime density and not in the spacetime curvature. With our approach, we cannot break down gravity into quanta.

If quantum gravity is ever discovered, the DP will be falsified.

3.11.3 Multi-dimensional approach with separate spacetimes

A many-worlds interpretation of QM sounds very much like DP. We have separate spacetimes. We have as many spacetimes as there are possibilities. We do the same thing in DP. At the level of keywords, this is all correct. In detail, however, we do something completely different in DP.

We only ever have a multitude of spacetimes via the lower-dimensional spacetimes. If our universe is a 3D spacetime, then in a measurement process in QM, an exact selection is made from a set of 2D spacetimes. This mapping from 2D produces an effect in our spacetime via the lower-dimensional boundary. We do not create worlds of equal dimensions in a measurement process. We reduce all 2D possibilities to the one that carries out the interaction. In cosmology, we will then see that a 2D spacetime is very different from our 3D spacetime. We do not have the idea that I exist in another universe where I declare DP to be nonsense. I exist only once in our universe and I do not exist in other 3D universes.

With the Higgs boson, we will also obtain an infinite number of 3D universes in the DP. However, these are not created by a measurement or similar. They already exist in our universe since the Big Bang and can only communicate via the Higgs boson.

If a many-worlds interpretation is ever established, the DP will be falsified.

3.11.4 Multi-dimensional approach with one spacetime

Here we have a similar situation. In the DP, we claim that low-dimensional and higher-dimensional spaces exist explicitly. In string theory, we have a different number of spatial dimensions depending on the configuration. Then there is the AdS/CFT correspondence. There, gravity is mapped one spatial dimension higher than the particles of QFT. The black holes in the lower dimension must also be an AdS spacetime in DP. It looks damn similar. Ultimately, for the mapping of a neutrino, we will have a structure with exactly one spatial dimension. That's a string!

I find it amazing how many similarities there are in certain aspects between the different approaches of the respective theories. But the theories work fundamentally differently. In DP, we can't do anything with any version of string theory. Let's take three points.

- There is still a separation between spacetime and the string as an object in spacetime. A string is not spacetime itself. There is still a stage and an actor, which are different. We no longer recognize this.
- The geometry of a 1D string should be recognizable in higher dimensions. The vibration of the string, or whether it is open or closed, must be recognizable in a spacetime with three spatial dimensions and one temporal dimension, i.e., our spacetime. We have just discussed that we cannot recognize geometry across different numbers of spatial dimensions. A basic assumption, that strings vibrate, cannot be verified by us. Therefore, these cannot be the elementary particles of the Standard Model.
- Properties are exchanged here across a number of spatial dimensions. This is not possible for us in DP. In an n-dimensional space-time, we can only recognize n-dimensional properties. With the boundaries, we then arrive at n+1 as a black hole and at n-1 with the speed of light. This is only via the respective dimensional boundary. If we assume, in string theory, a 10-dimensional spacetime, then all objects with different dimensions are in other separate spacetimes. We do not have a common spacetime across multiple dimensions.

DP and any form of string theory are mutually exclusive.

If a variant of string theory is ever discovered, DP will be falsified.

If a supersymmetric particle is ever found to be an elementary particle, DP is falsified.

If a compactified spatial dimension is ever found, DP is falsified.

That was a lot of points to consider. All of them stem from the limitations of spacetime. These limitations make DP possible in the first place, but they rule out virtually all other approaches.

With that, we will finally close this now very long chapter. Next, we will build one of the most important foundations of physics, the principle of relativity.

4 Special theory of relativity (ST)

SR is based on only two principles

- Relativity
- Speed of light

That sounds very simple. It is. Nevertheless, we will have to look at things here contrary to the textbook approach. With the DP, we have shifted an aspect that is important for the principle of relativity. It appears that spacetime density and thus also the state of motion has an "absolute" value. We will see that we cannot obtain absolute value in the SRT. However, there is information about smaller and larger between states of motion. According to the textbook approach to the principle of relativity, this is not allowed. Every object can be considered at rest, and there can be no smaller or larger. Even the term "state of motion" is incorrect here. This always depends on the chosen reference system. It is not possible to clearly assign a state of motion to an object. But that is exactly what we will do. To top it off, we will derive the principle of relativity for everything that exists in the universe. We cannot simply accept the principle of relativity as a postulate. We must justify it properly. Sounds exciting.

The counterargument always arises that the DP is a kind of Lorentz ether theory. It is important to note that we never use an ether. There is only spacetime. An additional ether in any form is explicitly prohibited by the DP. A fitting thought from the DP is that spacetime and ether are identical. Spacetime in the DP loses a crucial property compared to ether: spacetime can never serve as a reference for a rest point. But that is exactly what ether was built for. We must also take a closer look at this because the mathematics of the ether has been incorporated into Einstein's principle of relativity.

We have already shown in the previous chapter that the speed of light exists as a maximum speed. However, that is not enough. The postulate of the speed of light has two properties. It must also be shown why this limit is identical for every observer locally. If there is a smaller and a larger, then we can determine who is closer to the spacetime limit, right? No, we cannot. This has nothing to do with the fact that the speed of light is defined identically for all observers. Once again, it is a matter of all deformations of spacetime being a local change in the definition of geometry.

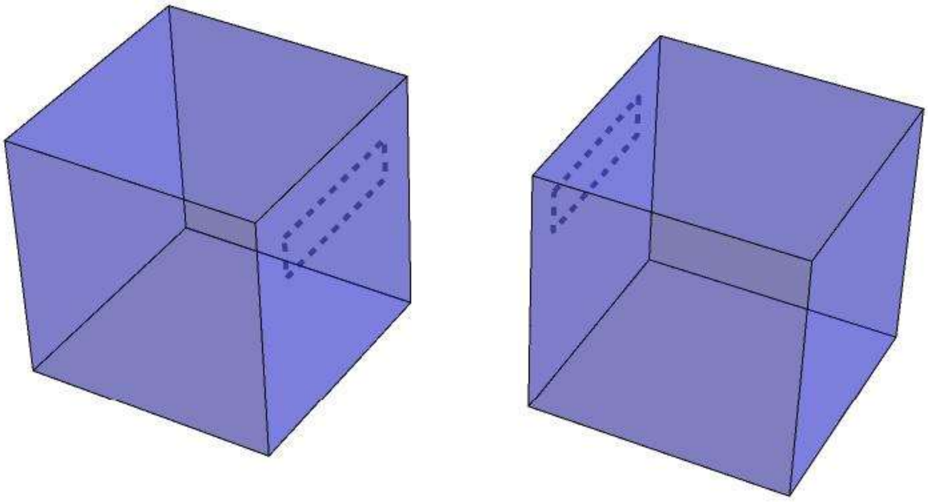
Contrary to previous explanations, we must start from scratch here. We will take the classic approach. We will start with Galileo and move on to Newton, Maxwell, Lorentz, and Einstein. Then we will see that Einstein got everything right with his combination of the speed of light and the principle of relativity, but he also allowed himself a lot of fun. This is often overlooked, but it is essential for us. Therefore, we will take a closer look at the sequence of developments. I realize that this section may be a bit tedious for "insiders." Please read it anyway. I am curious to see if you are already familiar with this insight. Most people overlook this and jump straight to the calculations. But then you haven't discovered the fun part of SR.

4.1 Relativity according to Galileo

Galileo is often regarded as the forefather of modern physics. For us, Galileo introduced one of the most important thought experiments in physics, the closed box. We need this in SR without interaction and in GR with interaction. This was the basic idea behind Galileo's principle of relativity. For Galileo, the closed box was a ship's cabin with no way of seeing outside. The whole thing was in very calm, flowing water. For Einstein, it was an elevator and later a spaceship. Everyone is a child of their time.

When we sit in a ship's cabin, we cannot determine whether we are moving with the water or standing still. This is identical to the question: Are we flowing with the water, or is the water flowing under the ship? There is no frame of reference or reference point to clearly determine the movement. From this, it can be deduced that movement can generally only be determined relative to a reference point. We extend the thought experiment with two boxes that only have a small viewing slit open. Nothing else can be seen except the boxes themselves.

Figure0-1: Two boxes with a viewing slit and nothing else



If we sit in one box and look out, we can see the other box passing by our box at a constant speed. If we cannot feel any acceleration, then we cannot determine whether we are moving and the other is at rest, or vice versa. Both boxes could be moving at different speeds, and neither is at rest. Both boxes could also be moving at the same speed in one direction, in which case we would not detect any movement between the boxes. The only detectable variable is the difference in movement between the two boxes. We can only determine the relative movement of the boxes in relation to each other. This results in the principle of relativity.

A principle of relativity always involves a transformation. This is the change of perspective from one box to the other. This is called the Galileo transformation. The calculation is so simple that a physics student would probably not be given exercise on it. This is precisely where the problem lies. Galileo's principle of relativity is so simple that no one bothers to think through the fundamentals. It is explained briefly, and that's it, done and dusted. We must make an effort to work out the basic principle behind it.

4.2 Measurements

The crucial question is: When do we obtain a principle of relativity? Let's address this fundamental question. The approach comes from the example of two boxes. A principle of relativity only arises if we can determine differences between objects (boxes) exclusively. We extend this statement generally to all measurements. This is not only the case with speeds. This is a general problem of measurement. We move away from speed and do this for a length. Then the examples become a little clearer.

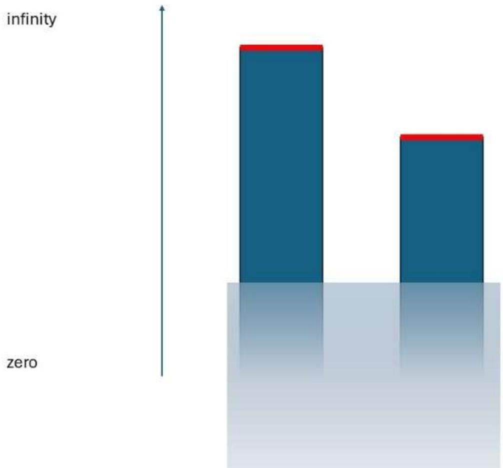
We can take a measurement if we have at least two measuring points. This is clear in the case of length. We cannot determine length with just one measuring point. Nor can we determine speed or electrical charge. However, the second measuring point is not always immediately obvious to us. The other measuring point is often the zero point. However, this can also be of maximum value. It does not matter whether we take a measurement at a maximum or minimum value. We always need two measuring points to specify a value. A measurement is a comparison. In our case, these were the two boxes. Then we can measure the difference.

We want to specify an absolute value. This is a value that must remain the same for any observer. Then we need a measuring point that is identical for all observers. Intuitively, we always equate this with the zero point. This means that as soon as we can define a general reference point for measurement for all observers, a principle of relativity is no longer possible.

Within a principle of relativity, we can agree on the measured value of a difference. We call this an invariant quantity. However, the measuring points that led to this invariant quantity must not themselves be "invariant." The measuring points must then shift. These must be explicitly different, otherwise we do not obtain a principle of relativity.

Let's rephrase the fundamental question: When can we only determine a difference? To put it bluntly, when we have lost the zero point. We are then unable to specify an absolute value. We no longer know a universally valid reference point. This necessarily results in a principle of relativity. The only information available is differences. It follows that this view must always be symmetrical between the objects. In the case of a difference, it must not matter from which

Figure 0-2: Relativity in lengths



object we start the measurement.

We have two lengths. We cannot determine the absolute values of the lengths. The zero point, the reference point valid for all observers, is not recognizable. The only recognizable features are the two red edges. We obtain a difference. In order to assign a value to the difference, we simply set the zero point on one of the red edges. In the case of a speed, we simply set a speed to zero. We can set the zero point arbitrarily based purely on mathematics. We do not know the "real" zero point. Intuitively, we select one of the edges. We obtain a symmetrical and relative measurement of the two objects in relation to each other. We cannot obtain an absolute value. Everything should be clear up to this point.

For an absolute value, we could also specify a maximum value. This is just as good as zero value. We have not yet discovered a maximum value for a length. In Galileo's time, this did not apply to speed either. Why should there be a maximum speed? There was no reason for it. So, it was sufficient to remove the zero point. Here comes the trick we need to remember. For Galileo, there was a zero point, absolute rest. However, we cannot distinguish this zero point from a straight and uniform motion. This means that the zero point can be set arbitrarily by the observer. Then you set yourself as the zero point.

Important: For Galileo, there is then also no greater or lesser for the values. A difference can also be a difference between a long and a short rod. However, to measure the length of a rod, we need a zero point. There is only one reference point for all absolute measurements. But that is precisely what is missing. It follows that, according to Galileo, there is always only a 100% symmetrical view between the objects.

4.3 Newton

The principle of relativity is so simple and logically clear that Newton also used it as the basis for his description of physics. Newton and Galileo agreed on the principle of relativity. Based on the definition of his axioms, we can best recognize Newton's view of the principle of relativity. Newton has three axioms:

1. A force-free body remains at rest or moves in a straight line at a constant speed.
2. Force is equal to mass times acceleration
3. Force has an equal counterforce

The strange thing about the axioms is that the second axiom seems to contain the first axiom. If we do not exert any acceleration, then there is no change. If we have no change, then a body remains force-free and thus at rest or in a straight and uniform motion, since there is no change. Why this duplication? Because it is not a duplication. The first axiom is the shortest and most beautiful description of the basis of a principle of relativity. At least as it was understood until Einstein. If you like, Newton included the principle of relativity as a postulate.

Newton did not do this as in today's textbooks on SR: Postulate, the principle of relativity applies. The crucial point in Newton's statement for us is that a force-free body can be at rest **or** in a straight-line and uniform motion. There is no way to distinguish between the two. He stated the reason for the principle of relativity. The general reference point for velocity, the zero point, is no longer valid. Newton explicitly includes the state of rest. Like Galileo, he assumed that this exists but is not detectable.

4.4 Maxwell

After Newton, the world was okay for about 200 years. Until James Clerk Maxwell came along. He achieved a feat like that of Newton. Newton brought together all the individual loose ideas on classical mechanics into a single, almost completely consistent theory. Maxwell did this with the individual parts of the description of electricity and magnetism and, with electrodynamics, also delivered a complete, consistent theory.

However, this has given rise to a problem we are familiar with. The two great theories, which were supposed to describe the entirety of physics at the time, did not fit together in some places. Somehow, the problems keep repeating themselves over time.

Let's pick out two important points.

1. The description of magnetic and electrical effects in relation to each other is incompatible with the Galileo transformation in certain situations. We need a different description for each chosen reference system. However, physics should not make any distinction between reference systems. In all inertial systems (at rest or in uniform linear motion, i.e., without force), the laws and formulas of physics should be identical.

2. According to Maxwell, we can define the speed of light with the following formula:

$$c = \sqrt{\frac{1}{\epsilon_0 * \mu_0}}$$

The problem with this description is that ϵ_0, the electric field constant, and μ_0, the magnetic field constant, are both unchanging natural constants. This is independent of the state of motion. Therefore, c must also be an unchanging natural constant. The speed of light must always be the same, regardless of the reference system. All natural constants must be identical in every reference system. These reference systems are inertial systems. This allowed them to move uniformly and in a straight line. How can the speed of light remain the same when observed from any inertial system?

At that time, Newton was the demigod of physics. Therefore, a solution was sought that had to correspond to Newton's description. Even Maxwell understood the problem in such a way that there must be something unknown in electrodynamics for the principle of relativity to work again at the speed of light. We did not obtain a new zero point, but we did obtain an absolute maximum value. This is a clear reference point for every observer. This means that the principle of relativity no longer works.

One solution was the ether. It was already suspected that this maximum speed belonged to light and that light was therefore an electromagnetic wave. So, this wave description of light had to have a medium, like waves in water or sound in air. This medium for the propagation and excitation of electromagnetic waves was supposed to be the ether. Then the speed of light only has this absolute value of speed in relation to the ether. Galileo's principle of relativity would thus be saved and only incorrect in relation to the ether. The ether then had to be the absolute zero point, i.e., the resting point, for the speed of light. The ether always had to have an absolute value, but not in relation to the observer's space (spacetime did not yet exist).

It was recognized early on that this ether must have very strange properties for all this to work. In addition, this ether could not be proven in any experiment. In particular, the experiment by Michelson and Morley in 1881 and 1887 caused major problems for the ether theory. The aim was to find an ether via the movement of the Earth through the ether. The result was negative and remained so to this day.

4.5 Lorentz

The rescue of the ether, only for this experiment, because the other problems remained, then came from Hendrik Antoon Lorentz. A new transformation was developed, the Lorentz transformation. This is structured in such a way that the existence of an ether is compatible with the Michelson-Morley experiment. To achieve this, however, the length in the direction of motion had to be shorter and time had to be slower. Length contraction and time dilation were already known before SR. For Lorentz, length contraction was only present in the electromagnetic field (ether) and time dilation was a purely mathematical aid.

Mathematically speaking, Lorentz had found a solution. Now here's the funny thing. It was developed for an ether theory. This means that the Lorentz transformation only works with an absolute zero point and the corresponding absolute velocity. That should be clear. If an absolute velocity is assumed, then there must be an absolute reference point. Here, it was the zero point in relation to the ether.

4.6 Einstein

But now, finally, to our joker. In my view, SR actually has several fathers. There were already several other developments by several people on this topic. Einstein contributed the final brilliant idea here. In my view, he made the following assumptions for the development of SR:

- Maxwell is right, not Newton! The speed of light is of the same absolute value for all observers.
- If the Lorentz transformation solves the problem mathematically, then it must be the correct model.
- The principle of relativity must be correct for all of physics. Maxwell's equations should not change depending on the reference frame.
- Since no ether has been found, there is none.

These points are sufficient to arrive at SR. We can use them to construct the following logic:

- There is no ether.
- This means that motion is direct in space.
- All conditions for a principle of relativity must lie directly in space.
- If the Lorentz transformation requires length contraction and time dilation for an absolute speed of light, then this must be mapped directly onto space and time.
- Since length contraction and time dilation are not independent of each other, space and time must be considered as spacetime.

This almost gives us SR. For a clear justification of length contraction and time dilation in spacetime, which was a very bold assumption in Einstein's time, Einstein argued extensively with simultaneity in spacetime. Better said, with the simultaneity that no longer exists. To do this, he had to make an additional assumption that had not been made before. The speed of light is not only constant, but also maximal. According to Maxwell, c is simply constant for electromagnetic waves. For Einstein, this now had to be maximal for any effect in spacetime. Only with this extension does SR result. Therefore, this condition looks like a "foreign body" in the theory to many others.

Due to the maximum speed, there can no longer be simultaneity for an effect from one spacetime point to another spacetime point. The effect always requires time between the spacetime points. We will now develop another approach that is more suitable for the DP and avoids the discussion of simultaneity for length contraction and time dilation.

4.6.1 Where is the difficulty?

If we follow this logic, then in my opinion we fail to recognize the joke in the matter. The same applies to the argument of simultaneity, which we will not pursue further here. But this is exactly how it is explained in textbooks. That is why almost no one notices it. Einstein did not simply change Galileo's old principle of relativity. He constructed a completely different principle of relativity. The basic assumptions of the Galileo transformation and the Lorentz transformation are mutually exclusive if we no longer have ether.

What did Einstein do that makes me think he's such a joker? His two principles are:

- Relativity
  - There is no identical minimum or maximum measurement point for all observers.
  - There can be no absolute value.
- Speed of light
  - There is an identical maximum measurement point for all observers: the speed of light.

- Since the Lorentz transformation originates from an ether theory, there must be an absolute state of rest, the minimum measurement point.
- Every value is an absolute value.

The two principles are mutually exclusive. This is what I meant when I said that the Galileo and Lorentz transformations are incompatible in their basic assumptions.

No problem, then Einstein is right and Galileo is wrong. Unfortunately, it's not that simple in DP. We will develop a third concept as an argument for a principle of relativity. This concept follows the assumptions of Galileo and Newton more closely. However, Einstein must also be right, even though the approaches are mutually exclusive. For 120 years, SR has been flawless in all calculations related to experiments. It cannot be wrong. The different approaches to relativity must be mathematically identical under certain circumstances. This feat can only be achieved if all deformations of spacetime are a change in the definition of spacetime geometry.

4.6.2 SR reinterpreted

This immediately raises the crucial question: Why does SR work at all? It never results in a principle of relativity. But it does, just not in the way everyone imagines. The two theories of relativity compare fundamentally different things. We can only understand this if we look at the basics. The chain of argumentation in textbooks always starts with Galileo and then moves on to this principle of relativity, modified by Einstein, to SR. Here, I am not sure whether Einstein himself recognized this difference. By doing this, we simply transfer Galileo's idea of the principle of relativity to SR. SR is the special theory of relativity. It sounds as if this is just a special case of relativity. This approach is wrong. What do we need to do to clarify this? Ask the next fundamental question.

What kinds of objects are compared in Galileo's principle of relativity? First, our two boxes. The boxes in relation to what? Only to themselves, since we have lost the reference point. The reference point in relation to what? The surrounding space. With Galileo and Newton, we can only talk about space. A spacetime with a dynamic definition of length and time was not yet known here. In general terms, this means that we compare the states of motion of different objects in identical space. This fundamental structure, which has never been questioned, is now transferred to SR. As we have learned from the principles, SR cannot do this. SR has to do something else.

I will spare you the next round of questions and give you the answer right away. SR is still a principle of relativity. It must compare objects. However, these are not our boxes in spacetime. SR compares two fixed spacetimes, each of which is assigned to a box. In SR, we do not compare two objects in one dynamic spacetime. We compare two static spacetimes that we assign to each object. A comparison, yes, but not actually the comparison we want.

A brief aside from my personal experience. When I was working out these fundamentals, I naturally discussed them with others. Sometimes in personal conversations or in a physics forum. In the process, I received the following interpretation of SRT from different people:

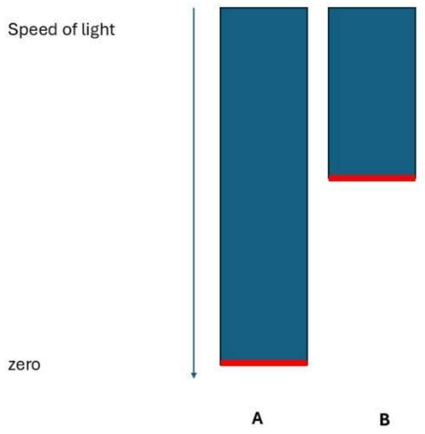
- The relative velocity of objects is compared in a single dynamic spacetime. This corresponds very closely to Galileo's old view, only in a dynamic spacetime. This also fits with what we experience. All objects in one spacetime.
- Absolute velocities are compared to a relative geometry in a single spacetime. I assume that this was also Einstein's idea. But that's just a guess.
- Each object is assigned an absolute spacetime based on its speed. The geometries of these spacetimes are compared with each other. This corresponds to the view of DP, for SR.

The crucial point here is that if I had put these people in a room and given them a purely mathematical task on SR, I am 100% sure that all of them would have come to the identical and absolutely correct result. They would have congratulated each other and claimed that we all understood everything identically because we could calculate it correctly. That is the difference between calculating and explaining.

4.6.3 Relativity between spacetimes

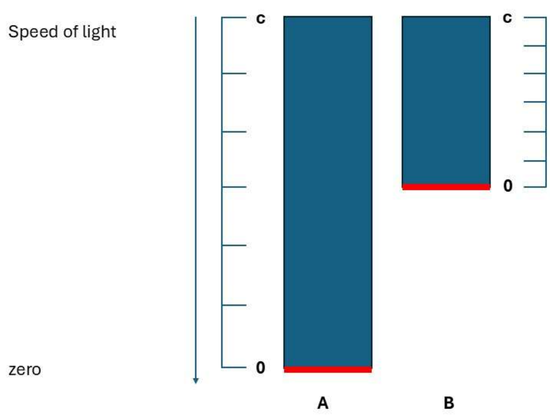
Can we create a principle of relativity between spacetimes? Let's take a look at a comparison according to SR.

Figure0-3: Length comparison at maximum reference point



Here we see two lengths again. Both start from the zero point with a different length relative to each other. Both lengths start from the zero point in their spacetime. Then we need the end point, the speed of light. This must be identical for all of them. Otherwise, a comparison between different geometries is not possible. This is precisely where a crucial point in SR lies. If we have a dynamic geometry, we need at least one absolute reference point so that we can compare the geometries at all. The speed of light takes on this role. The speed of light, as an absolute reference point, does not "mess up" relativity for us; we absolutely need it. We need the zero point in every geometry so that we have a uniform second "edge" for measuring differences. This is why the Lorentz transformation works with the absolute values for the rest point and the speed of light. We absolutely need these points so that we can compare spacetime geometry at all.

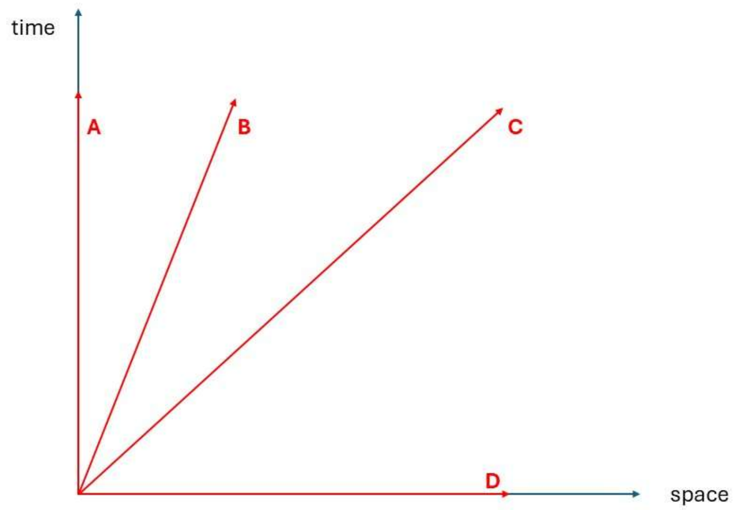
Figure0-4: Length comparison with dynamic geometry



To do this, a different length division must be selected at B. The number of divisions must be the same in both cases. From zero to the speed of light, the absolute value should be identical for all. This comparison is again symmetrical. We could set the rest frame at A and B. This allows A and B to be absolute values in spacetime A and B. That is not a problem. No comparison is made in the respective spacetime. Spacetimes A and B are compared. We see that the principle of relativity also works between differently defined spacetimes.

Then our condition must work for the spacetime itself and not just for an object in spacetime. The spacetime relative to each other must not have an absolute reference value. To understand this, let's look at the structure of a normal spacetime diagram.

Figure0-5: Spacetime diagram



Let's look at the given possibilities:

- Arrow A: We only have movement in time but not in space. There is no change in position in space, but time still changes.
- Arrow B: We move at a freely chosen speed in spacetime
- Arrow C: We move through space at the maximum speed of light
- Arrow D: We move only in space and not in time

In all cases, we move, even if only in time or only in space. What does not exist explicitly for spacetime is rest. Even if no object exists in spacetime and only spacetime itself exists, time still passes. In the mathematics of SR, this is also a movement. Spacetime as an independent object knows no state of rest. Fortunately, we have lost the zero again. Within spacetime, we simply set a resting point and generate absolute values. This is not possible for spacetime itself.

But what about maximum speed? We have the speed of light. Yes, but it is now absolutely necessary in order to make a comparison possible at all. If both spacetimes have different geometries, there must be a common reference point for comparison. Otherwise, we would not even be able to specify a difference.

For spacetimes, we can only define one reference point, the speed of light, and we urgently need this so that we can make a comparison at all. We obtain a genuine principle of relativity between spacetimes due to variable geometry in the spacetimes. This is the SR. This allows us to solve several problems at once. We can use it to explain why the twin paradox is so difficult for SRT, which we will do in 4.11. We can clarify a point that I have called cherry picking, which we will do in 4.10. We can explain why SRT fits better with QM than with ART in 4.12. We will see that with this interpretation, SRT really makes sense.

One question remains unanswered by Galileo's principle of relativity. Can there be a greater or lesser in SR? In SR, we only recognize differences. Anyone who wants to measure this difference must necessarily set themselves at the zero point. With Galileo, we only had one possible reference point. That had to go, otherwise we would not have a principle of relativity. That is not the case with SR. We have a zero point and the speed of light. But we need those to be able to determine the difference. In the first approach, no greater or smaller comes out. If we want to have such an indication, we explicitly need another reference point between the spacetimes. We will see that the twin paradox provides us with this and that we can therefore determine a younger and older. This is only possible in time and not in space. However, we will discuss this in the appropriate section.

Before resolving all these points, we need to take a different approach, which will make these solutions even clearer. First, we need to establish a new perspective on the DP. This should combine Galileo's principle of relativity, everything in one spacetime, and Einstein's principle of relativity, comparison of spacetimes. Believe it or not, we already know all the necessary components for this.

4.7 SR for DP

We are not introducing a new name for this variant of SR. The old variant according to Galileo and Newton is simply the principle of relativity. The variant according to Einstein is SR, and we have now recognized that it is actually very special. For our new variant, we will simply stick with the name SR. Since SR is mathematically identical in both variants, we do not need new names.

What do we want? We want a comparison of two objects in a single spacetime. Because that is what we actually mean when we talk about a principle of relativity (Galileo). Then we must be able to deal with different geometries of spacetime in a single spacetime without having to use an absolute value. As mentioned at the beginning, we do this with our spacetime density. This must contain all the necessary properties from both variants. Again, it sounds very difficult, but it's simple. We have already incorporated this into our approach. We do not distinguish between stage and actor. A spacetime density is always also spacetime itself. This means that the property only needs to be present, and then it is automatically there in both variants. We can also divide the variants differently. In Galileo, the actors are compared on a stage. In Einstein, the stages are compared. We no longer recognize this difference.

What makes life easy for us now is that spacetime density is always energy, geometry, and state of motion in one.

4.7.1 Spacetime density without zero point

If we want to compare two spacetime densities, there must be no zero point for spacetime density. We discussed this in detail in Chapter 3. A spacetime density of zero cannot exist. Otherwise, the spacetime point does not exist in spacetime. That concludes this section. By definition, there can be no zero point for spacetime density. Since the state of motion itself is spacetime, there can be no resting point in a spacetime density. Contrary to Galileo and Newton, we cannot simply fail to distinguish the resting point; by definition, we have no resting point.

4.7.2 Spacetime density without a maximum reference point

With higher momentum, we have more spacetime density. I can relate this to the speed of light. For spacetime density, the limit is infinite. This means that there is no limit value. However, for the state of motion, there is an absolute value, the speed of light. This provides a reference point. There should be no principle of relativity for speeds in DP. We are not giving up that easily.

We have the speed of light in spacetime. This is clearly defined by geometry and is therefore an absolute value. The statement is correct. Nevertheless, we have no reference point in spacetime. We only have one between spacetimes. We use the same trick here as Newton did with rest. There we had rest **or** straight and uniform motion. Since we cannot distinguish between the two states, the zero point has been eliminated. Something similar happens with the speed of light. It is always identically far away for every object and therefore cannot be used as a reference point for a measurement within a spacetime. That was Einstein's basic idea. However, it is a postulate. We cannot use it as such. We have to derive this constancy of the speed of light. We will do that in the next section.

4.8 Constancy of the speed of light

We discussed the existence of the speed of light in detail in Chapter 3. As a structural element of spacetime, it is necessarily given by the spacetime boundary. However, this is only the first step. We have an identical condition. This **does not** explicitly generate the constancy of the speed of light.

In the second step, we must show that, despite this condition, we have an identical distance to every object. There are two possibilities for this. One of them is wrong. Unfortunately, the wrong possibility is very often used. Let's take a closer look at the two possibilities.

4.8.1 Speed is a fraction

We already discussed this topic in relation to Planck's constants. Speed is a fraction $\frac{Leng}{Time}$. This means that there are an infinite number of values that lead to the same speed. In SR, the dimensions of length and time change identically. This means that the value of the fraction does not change overall. Length and time become smaller and larger to the same extent. Speed therefore does not change and must remain the same locally.

Part of the argument is correct. We cannot detect any change. The second part, that this happens because the speed does not change its value as a fraction, is unfortunately incorrect, even though it appears to be correct.

The best counterexample is the Shapiro delay, as it has been well confirmed experimentally. We will discuss this in more detail in the next chapter on the equivalence principle of GR. What is important for us now is that light in a gravitational field can also move slower for an external observer. Locally, however, light must again travel at c. Here, length and time change in opposite directions. This never results in a locally constant speed over a fraction. Although we are in SR, we need a more general solution that also works in the context of gravity.

4.8.2 No change detectable

The first thought was that we can detect the changes, but they cancel each other out. For the constancy of the speed of light to work, we must not be able to detect a change in the components of spacetime locally in the first place. Then it is irrelevant what the environment looks like or how the spacetime components behave in relation to each other. We achieve this by defining the geometry of spacetime density. Since everything in the universe is spacetime density, the local constancy of any given quantity is also achieved.

Let's start with length. The change in the space component can be whatever it wants; we can never detect it locally. The meter as a reference size is not squashed. It is **defined** differently locally for the object. If a spaceship flies at approximately 86% of the speed of light, then the meter is only half as long for us in the direction of motion. However, there is no physical way to determine this inside the spacecraft. Absolutely everything in the spacecraft now has a new definition of length. A meter always remains a meter locally. We cannot detect the change locally.

Time behaves identically to length. The second is now defined differently. There is no way to determine this. But we have defined time as a measure of distance to the spacetime boundary. The spaceship has moved closer to the spacetime boundary. Yes, that's right. Locally, we cannot determine this either. We would have to be able to detect length contraction or time dilation in order to determine this. We do not have this possibility. From the perspective of the spaceship, it has not moved any closer to the spacetime boundary. Therefore, locally, everything remains as it is.

Locally, it is not possible to detect a change.

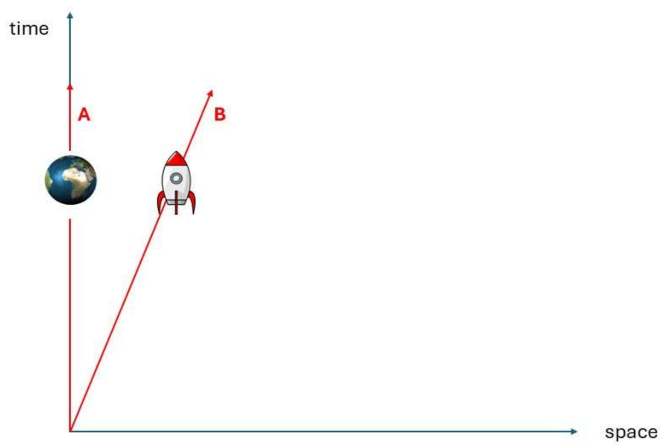
Locally, no approach to the spacetime boundary is detectable. It must always remain identically distant. This results in the constancy of the speed of light.

This "no change detectable locally" does not only imply the constancy of the speed of light. It also explains why, according to SR, we can place everything in a rest frame. The distance to the spacetime boundary does not change locally and there is no zero point. This means that every object can be considered at rest without acceleration. If the definition of length and time does not change, then we always have an initial frame. Every local observer has a good definition of length and time. These may differ locally from observer to observer, but locally, each observer has a unique definition and thus an inertial system. This is the reason why we can work with the idea of an inertial system in the first place. This is the connection between SR, comparison of spacetime, and the old principle of relativity, comparison of objects in spacetime.

4.9 Example of SR according to DP

Let's look at the principle of relativity in DP using an example. We'll use the classic example of a person on Earth and a person in a spaceship moving away from Earth.

Figure0-6: Classic image of a symmetrical view



Then we have two views to discuss. One from Earth and one from the spacecraft. We'll start with the simple case.

4.9.1 View from Earth

Here, SR and DP agree on the perspective. Therefore, the case is simple. The person on Earth experiences no change in their state of motion. Thus, the spacetime density remains identical. For SR, this person simply remains in the rest frame. The spacecraft is accelerated and thus actually acquires a higher spacetime density. The spacecraft experiences length contraction and time dilation. This can be measured in real terms from Earth. However, nothing can be detected in the spacecraft itself; there is agreement on this point.

Length contraction and time dilation are real physical changes to the spacecraft. They are not just a point of view. It is precisely this statement that leads to the assumption that spacetime density is not subject to any principle of relativity.

4.9.2 View from the spacecraft

At first glance, everything seems very simple in SR. Once the spacecraft has completed its acceleration phase, it can claim to be at rest. The Earth has accelerated and is flying away from the spacecraft. The Earth must now necessarily be subject to length contraction and time dilation. A completely symmetrical view.

This is precisely where the problems begin in understanding SR. The acceleration phase has taken place solely and exclusively on the spaceship. Why should the Earth now be different than before? The Earth is not sufficient in this consideration. In the direction of motion, the entire universe must have accelerated. No, definitely not. The universe does not change just because a spacecraft somewhere had an acceleration phase. This is the best way to see that SR does not compare two objects (Earth and spacecraft) in one spacetime. Depending on the perspective, the objects are assigned a suitable spacetime, which always ranges from zero to the speed of light. Then the comparison of the spacetimes is made. Therefore, from the perspective of the spacecraft, the entire universe must have undergone a change. Only the spacecraft had an acceleration phase and received this new definition of spacetime. However, it is a definition of a complete spacetime.

However, SR only recognizes one direction in comparison. The other object always has the "smaller" definition with time dilation and length contraction. In a principle of relativity, there should only be a difference and no specific direction. This in turn results inevitably from the approach with the Lorentz transformation from an ether theory. This assumes a zero point that is identical throughout the entire universe. Therefore, in SR, we obtain this preferred direction in the comparison.

In DP, only the spacecraft may have the higher spacetime density. Only there has acceleration occurred. Then the spacecraft has a changed definition of geometry. The spacecraft recognizes, just like Earth, that there is a difference in the definition of geometry. Only this difference is recognized. Even if it is clear to the spacecraft which one must have the higher spacetime density, we cannot measure this from inside the spacecraft. The spacecraft now has a different definition of geometry. The spacecraft can now only recognize all observations to the outside world using its definition. Let's proceed strictly according to SR. Then the spacecraft is at rest and the Earth has accelerated. What does it look like for the spacecraft according to DP? The Earth has definitely maintained its speed. But so has its definition of spacetime. The meter on Earth is defined as longer than the meter in the spacecraft. Then, from the spacecraft's point of view, Earth creates more length at the same speed. This means that, for the spacecraft, Earth must have accelerated. Not just Earth, but the entire damn universe. Only the spacecraft has changed its spacetime density. This means that, for the spacecraft, the entire universe must necessarily undergo a change.

DP only makes a spacetime change to the object that has also had an acceleration phase. But then there is a global change for the object. SR does this by always assigning a complete spacetime to each object. Then the DP and SR perspectives seem to be identical. So why all the fuss? Because they are not identical.

In DP, the spacecraft actually has a higher spacetime density. In SR, we cannot determine this. Only a symmetrical approach is possible. In DP, it is clear that length contraction and time dilation are only local phenomena. In SR, these are always global from each perspective. We will clarify these two points in the next two sections.

4.10 Cherry picking in SR

According to SR, time dilation and length contraction always occur identically and are physically measurable throughout spacetime. But then we encounter a logical problem. Mathematically, everything is clean because it is symmetrical. Logically, however, it becomes critical. The approach from DP solves this problem very easily.

As always, I have arbitrarily named this problem "cherry picking." When I sit in my chair and write this text, I have a defined time and a defined length between my two hands in front of me. Now muons are continuously approaching this length from all sides of the Earth's atmosphere. Since muons are very fast, the length must be different for these particles, depending on the angle to my hands. We cannot really imagine this.

Almost all discussion partners make a rather idiosyncratic distinction here. Each muon must have a different time than mine. These are objects that are different from my hands. They can have different time courses. Since time remains a mystery, this is simply accepted. This is a good thing, since time dilation has now been verified with impressive accuracy through experimentation. Hack on it.

According to SR, however, the length must also change physically. Time dilation only occurs with length contraction. Time dilation is measured experimentally, so conversely, length contraction must also occur physically. This means that the distance between my hands must constantly change, depending on the angle at which the muon moves toward my hands. Almost no one accepts this. Many abandon the path of virtue and go for what is logically understandable. Length contraction is only one point of view; time dilation is real. From a logical and mathematical point of view, this makes no sense in SR. Either both are just a point of view, or both are physically measurable. We are certain about time because it is measured. When it comes to length, we don't want to accept it, just "cherry picking." The problem arises because SR always assigns a complete spacetime. In fact, this does not make logical sense. But since mathematics works very well => shut up and calculate.

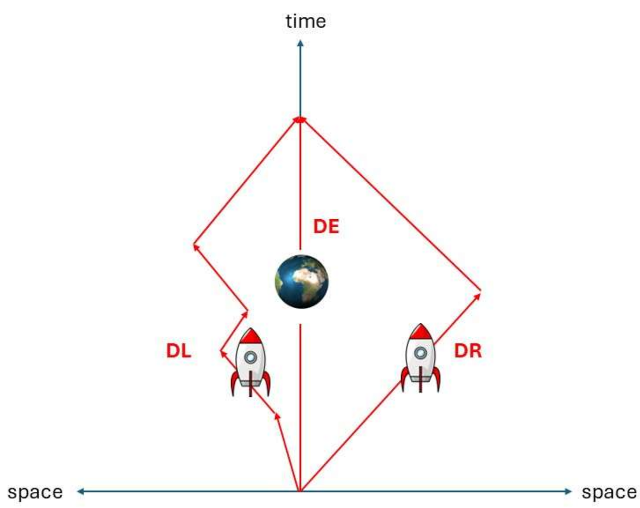
In DP, it is clear. It is always a real physical effect. However, this is only local to the object. From the object, the appropriate view of the rest of the universe, which is unchanged according to the local definition, then results. Cherry picking is not necessary.

4.11 Twin paradox

Sorry, but if we're going to chew through SR, we can't leave out the twin paradox. In particular, this paradox allows us to clarify the problem with information about greater or lesser spacetime density. Most other paradoxes (e.g., the garage paradox) are rather uninteresting. They can always be explained by the symmetrical view of non-simultaneity. In the twin paradox, however, there is no symmetrical result. There must be a reason for this.

In mathematics, there is no difference. Even SR concludes that the twin in the rocket is always the younger one. This is also the expected result in DP. In SR, however, it is not clear why this is the case. Arguments such as symmetry breaking are often used to explain this. For a better understanding, let's extend the twin paradox to triplets.

Figure0-7: The triplet paradox



There is a triplet on the left (DL), a triplet on the right (DR), and a triplet on Earth (DE). DR has a single destination, while DL visits several locations. DE remains on Earth and only moves forward in time. What may not be 100% clear in the image is that the total distance traveled by DL and DR should be identical.

The result is clear. The triplets are the same age at the starting point. When they meet again, DL and DR are the same age, as both have traveled the same distance through spacetime, and DE is older than the others.

In DP, this result is logically to be expected. Only DL and DR experience an increase in spacetime density. Only DL and DR can experience time dilation compared to the starting condition. It does not matter in which direction the time dilation occurs. Only the sum of the time dilation, i.e., the distance traveled, is relevant in the end. Here, there is information about younger and older or smaller and larger spacetime density.

This is not clear from SR. SR is always symmetrical. This means that between DE and DL, the other must experience identical time dilation and there should be no difference. However, the result looks different. Why does this happen? I have not yet read a good explanation for this. The most common explanation is the most obvious one. If symmetry no longer exists, then it must have been violated. Because there is nothing else, the culprit is quickly found. The evil, evil acceleration. This must break the symmetry. Then come even worse statements, such as: "SR cannot handle acceleration." What nonsense. SR can only and exclusively do nothing with gravity. Any type of classical acceleration can be incorporated into the diagram or calculations with 100% accuracy.

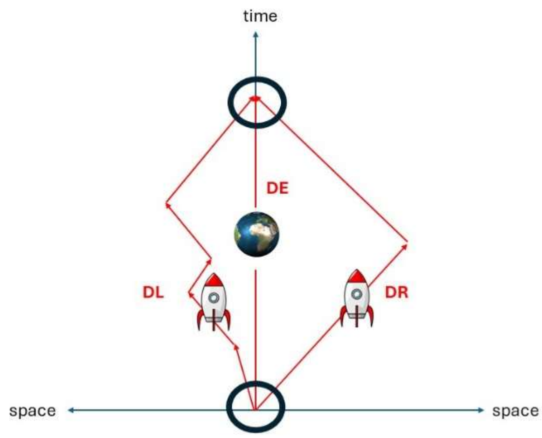
So, now calm down and tackle the solution. If the information is not already available, we cannot obtain it. We cannot generate additional information. The information must always be contained. In DP, we always have this information. We just cannot determine it in SR. It can only be extracted under certain conditions. That is the correct approach.

It can't be the accelerations. We have expanded the twins to triplets to make this visible. We could also let DL fly through spacetime even more "back and forth". If the sum of the distance traveled in spacetime is identical, DL and DR are identical in age. The number and direction of the accelerations are irrelevant. Acceleration is only necessary so that there is a change in spacetime density and the triplets can meet again.

What many people don't notice is that in the classic twin paradox, the twin in the spaceship makes two symmetrical breaks. The first when he takes off from Earth. The second when he takes off again from his intermediate destination. Then the first symmetry break is a "good" one, because everything is still symmetrical, and the second symmetry break is a "bad" one that ruins everything. With
good and evil do not work in physics. That is poor reasoning.

Let's return to the basic elements. When did we have to switch from an absolute value to a principle of relativity? When we lost the reference points for measurement. If we want more information, there must be a reference point again that can provide this information. The image again with the two important points.

Figure0-8: The reference points in the triplet paradox



What is special about this paradox is the starting point and the end point. The starting point is identical for everyone in spacetime. The end point has remained identical in space and has shifted in time. It should be the identical spacetime point for each of the triplets. Within the principle of relativity, we have created an additional reference point for measurement. This gives us all the information about space and time that deviates from this reference point in the principle of relativity. Then, even in SR, one comes out younger and one older.

In Galileo's theory, there is no smaller or larger. Not because he did not yet know about spacetime, but because there is only one reference point for everything, the zero point. In order to determine larger or smaller, we would also have to use the zero point in Galileo's theory. However, this point must no longer be recognizable, otherwise there is no principle of relativity. Therefore, Galileo's view is actually 100% symmetrical. This idea is transferred to Einstein's SR and everything, except for the twin paradox, looks good. Only when comparing two spacetime points is a larger or smaller not explicitly excluded. That is allowed to exist. However, in normal cases, we can only recognize the difference between spacetimes. In DP, the local spacetime definitions are compared. Here, too, in normal cases, only the difference is visible, and everything looks symmetrical. However, we know that there is a larger and smaller. In SRT, as in DP, we simply need an additional reference point to obtain this information. The twin paradox provides this.

4.12 SR to QM and GR

The last section in this chapter addresses the fact that the naming of SR and GR has, let's say, been unfortunate, to say the least. We can no longer change the names. They suggest that SR is the little sibling of GR. I would like to contradict this here. From a purely mathematical point of view, I can still understand the statement. From a logical point of view, it is simply wrong. At this point, it is also clear that many people are good at calculating with SR. However, very few have understood SR. We will stick to the approach from DP.

What does GR do? It states how the spacetime components change due to spacetime density. This statement only makes sense within a single spacetime. Spacetime density is only the source. The actual statement does not concern spacetime density. We can see this from the fact that GR predicts a singularity. This is not possible with the approach of spacetime density. For GR, only the amount and distribution of spacetime density across the spacetime dimensions is of interest. Spacetime curvature must then compensate for this. GR makes statements about spacetime curvature. This applies to the surrounding area of spacetime density in a single spacetime. Several spacetime densities, spatially separated, can also exist there. This statement of GR concerns the surrounding spacetime.

What does SR do? In the old view, different spacetimes are assigned to objects and these are compared. This makes it appear as if SR makes a statement about spacetime. But SR cannot do that. Different spacetimes are compared. SR cannot make any statements about a single spacetime or a single object. We always need at least two objects, otherwise SR makes no sense. In DP, it becomes a little clearer. SR compares the local definition of the spacetime geometry of different spacetime densities. These are statements about spacetime density. Just because the rest of spacetime appears different from this definition, we believe that SR makes a statement about spacetime. Clearly, in DP, everything is spacetime, so every physical statement is a statement about spacetime.

SR makes absolutely no statement about the surrounding area of a spacetime density. It is only a comparison of spacetime densities. GR needs a spacetime density as a source of spacetime curvature. However, GR is not otherwise interested in spacetime density and only makes statements about the surrounding area. From this we conclude:

GR and SR result in two completely different statements.

SR is simply included in GR because, by definition, the principle of relativity in DP must be incorporated into all physical statements. Everything is spacetime density, and this is always subject to the principle of relativity.

What does QM do? It describes the "internal structure" of a spacetime density through low-dimensional spacetimes (fields). However, QM is only interested in spacetime density. Spacetime density knows no spacetime curvature. QM uses the surrounding area of spacetime density only as a "given possibility." A low-dimensional spacetime density cannot determine whether this has spacetime curvature. This means that the surrounding spacetime is of no interest to QM. Therefore, SR and QM can be unified to a certain extent. Both look at spacetime densities and not at the surrounding area.

This concludes this chapter. In the next chapter, we will take a closer look at GR.

5 Equivalence principle of general relativity (GR)

GR is based on only 3 principles

- Relativity
- Speed of light
- Equivalence principle

We have already derived the principle of relativity and the speed of light in the chapter on SR. For GR, the principle of equivalence is still missing. There are two of these: the weak and the strong principle of equivalence. We will treat both separately. The strong principle is sufficient, as it includes the weak principle. Hence the names chosen. The separate derivation is interesting for the logical structure. The astonishing result of the derivation is that spacetime itself is a potential field. This becomes very important again in cosmology, in a different form. In GR, the vector potential field of spacetime is identical to the potential field of gravity. All other potential fields in physics function according to the same principle. In QM, they do so in different spacetime configurations.

In addition, in this chapter we will clarify what a force is in the classical description of physics. This helps in understanding gravity. Einstein's ingenious idea of a force as a geometric mapping in spacetime is not always immediately understandable. We then find it easier to see why we can use such different descriptions for an identical phenomenon.

5.1 The weak equivalence principle

Let's start small, then we can build on it. The weak equivalence principle is already contained in Newton's good old mechanics. In classical mechanics, however, it was unclear why this is so. Here, the principle is often referred to as the equality of inertial and gravitational mass.

5.1.1 Newton's first and second axioms

What $E = mc^2$ is to Einstein, $F = ma$ is to Newton. The two most famous formulas in the world. Force is equal to mass times acceleration. Newton's second axiom. The mass m in the formula is inertial mass. Inertial because it does not change its state of motion unless acceleration acts on it. The more mass there is, the greater the acceleration we must apply to achieve an identical change. No acceleration, no force, and therefore no change => inertia. Since mass is the only object in the formula, this inertia must be linked to mass. So far, so simple.

Same question as with SR. Why then is there the first axiom? Well, do you still know it by heart? Let me help you: "A force-free body remains at rest or moves in a straight line at a constant speed." We already had that in the second axiom. No acceleration, no change. Why does this statement appear twice in separate axioms? Here is an argument without the principle of relativity. For this to make sense, we have to read the first axiom differently. We reverse the statement: if no forces act on a body, then what the body does is rest or move in a straight line at a constant speed.

The first axiom is also a measurement rule. We can measure what a straight and uniform motion is. In a spacetime with spacetime curvature, "straight" is not so easy to determine. This makes a popular statement about gravity questionable. A body in a gravitational field falls without force in a straight line toward the center of gravity. We will see that this statement should be treated with caution. Here we will learn the difference between a potential field and a force.

5.1.2 Equality of inertial and gravitational mass

Newton's next famous formula is the formula for gravitational force

$$F = \frac{G \; * \; M_{grav} \; * \; \; m_{grav}}{r^2}$$

The large M is supposed to be the Earth and the small m a test mass. The mass here is the gravitational mass. That is what the scales show. We put this formula together differently.

$$F = \frac{G \; * \; M_{grav}}{r^2} * \; m_{grav}$$

According to the units of measurement, the first term with the fraction is acceleration. For the Earth as M, this results in the familiar small g for the acceleration due to gravity. This gives us:

$$m_{träge} * a = m_{schw} \quad * g$$

If anything is to fit together here, we must be able to eliminate the different m or g and a. This brings us to the following statements:

- Inertial and heavy mass must be identical.
- Since the masses can be eliminated in order to describe only the acceleration, no properties of m may be relevant to the effect of the acceleration. Shape, size, or chemical composition are all irrelevant. Result: On the moon, a hammer and a feather fall to the ground identically.
- Here we can already see that the effect of gravity must be treated as acceleration.

The identity of inertial and gravitational mass was a mystery to Newton. We see that it must be so, but there was no reason for it. This identity has been verified very precisely in 2026. A deviation can only occur after the 14th decimal place. It is one of the most thoroughly verified values ever.

5.1.3 Equality in DP

In DP, the approach is completely different. Every mass is a spacetime density. There is no characteristic for differentiation. All known characteristics for differentiation lie in QM and not in GR. This means that these characteristics cannot produce any difference when a "force" is exerted via gravity. We do not have to justify equality; it is necessarily given by the approach. We turn the tables. We do not even have the possibility of describing a difference.

If a difference is ever detected, no matter how far behind the decimal point, the DP is falsified.

5.2 The classical concept of a force

Somehow there must be a connection between force and gravity as a geometric mapping. The strong equivalence principle refers to acceleration. In classical mechanics, this always generates a force. The solution is already contained in Newton's axioms. First and second axioms: A force is a change.

In DP, we can understand classical force as a change in spacetime density. Without interaction, spacetime density remains what it is. Interaction can cause it to change. That is very simple. However, we have a big problem, especially with gravity. What is exchanged in an interaction? The long-sought graviton as the exchange particle of quantum gravity? No, definitely not!

In GR, there is only a geometric representation as spacetime curvature for gravity. All mass-energy equivalents are collected in the stress-energy tensor. In the Einstein tensor, we do not have spacetime density as an exchange particle. However, we still need a change in spacetime density. This is precisely where the strength of DP lies. We have curvature or density, but nothing more. It cannot be density. There is only one possibility left. The spacetime curvature must cause a change in the spacetime density without an exchange particle and **without a change in the spacetime density**. I know the sentence sounds a bit silly. But that's exactly what I mean.

Ultimately, we have to come to the strong equivalence principle. There, gravity must not be distinguishable from acceleration in its effect on a mass. Thus, the curvature of spacetime must produce a change in the density of spacetime that corresponds to acceleration. The DP could also have been deduced if one wanted to fully explain the concept of a potential, in this case the gravitational potential. Unfortunately, people were already satisfied with the exact calculation. The reason why was no longer interesting.

For us, force is a change in spacetime density. Since spacetime density is also a state of motion, it should come as no surprise that force is associated with acceleration. Changing a state of motion requires acceleration. This clarifies the concept of force. Let's move on and finally take a look at the strong equivalence principle.

5.3 The strong equivalence principle

In the strong equivalence principle, we cannot distinguish the **effect** of gravity from the **effect** of acceleration. Gravity and acceleration do not have to be identical; we just cannot distinguish between their effects.

We saw the first approach in the weak equivalence principle. There, a and g had to be identical. Einstein then came up with the idea that motion in a curved space must correspond exactly to this acceleration. As we can see from the word "effect," it was already clear to him that this is realized with different phenomena.

Figure2: Effect of gravity

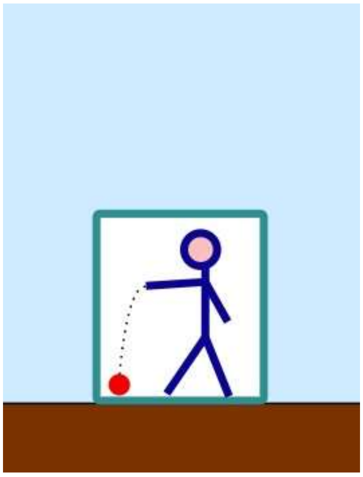
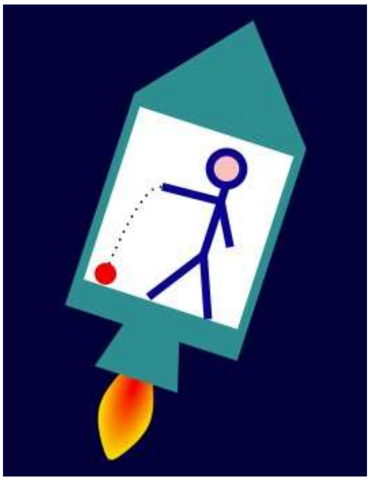


Figure1: Effect of acceleration



We are back on the road with Galileo's closed box. In SR, there was no external effect. Here, it is gravity or the acceleration of the rocket. In both boxes, we cannot determine whether it is gravity or acceleration with any experiment. The effect is identical.

5.4 The problem with "falling"

Since the concept of spacetime deformation was not yet widely understood at the beginning of general relativity, the old analogy with acceleration was retained. In order to obtain an effect similar to acceleration, the test object m must "fall" into the center of gravity in curved spacetime. I believe that this analogy has slowed down the search for the "why" question. The moon falls toward the Earth. Since spacetime is curved, the moon falls in its orbit around the Earth. This can also be calculated very well. Everyone can understand this, and everyone is satisfied.

Not us! This analogy explains nothing. According to calculations in general relativity, the moon moves around the Earth on a geodesic. This term refers to the direction of motion without the influence of any force. In a spacetime without gravity, this is a straight line. With gravity, it is the almost circular orbit around the Earth. Force-free, which reminds us of Newton's first axiom. In a flat spacetime, straight and uniform. In a curved spacetime, always following the curvature. But that is precisely the measurement rule that states that the moon is not subject to any interaction. No acceleration and therefore no change. Where is the effect of acceleration supposed to come from? The first axiom and the second axiom are mutually exclusive in the case of acceleration. In GR, however, it is assumed that both can exist simultaneously. The force-free moon (since it is on a geodesic) falls (and thus accelerates) around the Earth. No, that's not how it works.

So, let's calm down a bit and continue. There is no external interaction, and yet we still need a change. This change remains constant, for example in the case of the moon, over billions of years. This question has never been resolved. So, let's do that now.

5.5 Conservation of energy

The first idea we can have is that the value of spacetime density changes in a spacetime curvature. Then we have no interaction from outside and still have a changed value. That sounds very much like the solution we are looking for. In the spacetime curvature, the length becomes larger and larger and the length of the spacetime density remains the same. Then, in relative terms, the density becomes larger and larger. This means that spacetime density undergoes a perpetual change = acceleration due to the environment. Yes, but we have a **spacetime**. In the time dimension, the opposite is true and everything balances out again.

Don't be sad, that's a good thing. We need energy conservation. Spacetime curvature does not change the spacetime density for its area. Remember the constant surface area. This means that the ratio of a spacetime density to the surrounding spacetime with spacetime curvature does not change either.

Ultimately, we have no interaction from the outside. This means that the ratio of the spacetime densities of the environment and the object cannot change. But we only have spacetime curvature and spacetime density, so where else could it come from?

5.6 Change in components

The only thing that remains now are the shifts between the spatial dimension and the temporal dimension in spacetime curvature. Let's take a closer look at this.

A spacetime density moves toward Earth at 1 m/s. Far away from Earth, this is a straight-line and uniform motion. Here again is the important note: spacetime density is always the state of motion. Since we have no external interaction, the speed must remain the same. No change in spacetime density is identical to the same state of motion. However, in spacetime curvature, space and time change their definition. The meter becomes longer, and the second becomes slower. But this only happens with the surrounding spacetime and not for the spacetime density. The speed must remain at 1 m/s. This means that the spacetime density must become faster. It now has to cover a longer distance in less time. The spacetime density is accelerated solely due to the opposite change in the space and time dimensions. Locally, the spacetime density is free of any force, as it does not change. This somewhat strange acceleration is exactly what we need:

- No change in spacetime density
- No interaction from outside. Important! Any interaction, e.g., a graviton, would destroy this logic. Therefore, there must be no exchange particle for gravity.
- The spacetime density is always subject to this acceleration
    - I am writing this text while sitting on a chair. So no movement.
    - Why do I feel my weight? I am not falling toward the Earth at the moment.
    - Newton's first axiom also applies at rest.
    - The difference between the definitions of spacetime curvature and spacetime density alone produces acceleration. This also exists at rest.
    - Since every spacetime density has a spacetime volume, this difference in spacetime density is always present. The part closer to the gravitational source has a greater difference than the part further away from the gravitational source. Spacetime density thus acquires a clear direction. Always along the geodesic.
- The acceleration is thus aligned with the spacetime curvature.
- The acceleration comes from the change in the surrounding spacetime.
    - The properties of spacetime density are irrelevant.
    - The acceleration is identical for any spacetime density.

The strong equivalence principle results from the opposite deformations of the spacetime components in a spacetime curvature. The spacetime density does not explicitly undergo any change or interaction. We obtain acceleration because the state of motion must not change. That is the joke of the equivalence principle according to the DP. Here we see again how important it is that this deformation is a change in definition and not just a point of view. The equivalence principle only works with a change in definition.

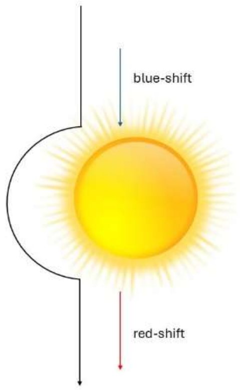
5.7 The counterpart, Shapiro delay

The change in the spacetime components can also have the opposite effect. This happens precisely when acceleration can no longer increase speed. We must consider the special case of the speed of light. Here we have two possibilities:

- A change in wavelength. This happens with red or blue shift. We will discuss this in the next section when we take a closer look at the concept of potential.
- A reduction in speed. There is no change in wavelength, or rather, blue and red shifts cancel each other out. However, the distance traveled becomes longer due to a change in definition. The spacetime density can no longer cover the same distance at its speed. Light cannot become faster. It cannot accelerate further. Thus, with a longer distance and less time by definition, light must slow down. This is the Shapiro delay.

Let's look at the following image:

Figure3: Shapiro delay around the sun



A photon traveling at the speed of light flies very close to the sun. As the photon flies toward the sun, it is blue-shifted. As it flies away from the sun, it is red-shifted to the same extent. Overall, there is no change in frequency.

However, the photon must follow the curvature of space. This results in a longer path for the photon. Then the longer path simply has to be traveled at the speed of light, and everything is perfect. This is what people thought until Mr. Shapiro discovered a deviation for light in the mathematics of general relativity. Light signals must have a lower speed when passing a mass. The effect has been experimentally confirmed to approximately 4 decimal places.

Even at the risk of boring you to death. Here, too, we see in the equivalence principle that the change in the spacetime metric must necessarily be a change in the definition of geometry. If this curvature were only a longer distance, this effect would not occur.

The photon has the maximum speed. In spacetime curvature, by definition, the distance becomes longer and the time shorter. Acceleration is not possible. In this environment, the photon slows down for an observer. Locally, the photon retains the speed of light, as we discussed in SR.

In fact, Einstein had already encountered a delay. But it was Mr. Shapiro who came up with the correct result. Einstein was missing a 2 in the formula. But it is important. We have a longer distance and a slowed-down time. Therefore, the delay is doubled.

5.8 Repulsive Gravity

Is there such a thing as anti-gravity, like the positive and negative forces in electricity? With gravity, everything is always attractive. According to general relativity, yes. That was a very surprising result from the mathematics of general relativity. Gravity has a repulsive effect when it becomes too strong. In mathematics, this is possible because GR is not a linear equation. It is rather difficult to understand this using pure logic alone.

This does not mean that gravity is cancelled out by the geometry of the object. The center of a hollow sphere has no gravity, even though it is surrounded by mass. Since gravitational force is a vector force, it cancels itself out at the center. If we use the Kerr metric instead of the Schwarzschild metric to solve the field equation, this also happens at the center of a black hole. The singularity is then not a point, but a ring in the center of a black hole. This is because the Kerr metric can map a rotating black hole. This is also the more exact solution. Due to the rotation, the singularity is not a point, but a ring. In the center of the ring, gravity is zero. Gravity toward the singularity is canceled out.

What we want is a repulsive effect, not a cancellation. According to GR, this repulsion exists at the center of a black hole, where gravity is very strong. This is why ideas keep cropping up that our universe is the center of a gigantic black hole. Since this is what mathematics indicate, it is simply assumed.

What does DP say about this? Since we want to confirm the mathematics of GR, except for the singularity, something like this should also exist. That is exactly what happens. With one crucial difference. Once again, we can clearly explain the reason for this "repulsion." In DP, we only need this repulsion in the case of very high gravity, or rather, very high spacetime density.

Spacetime curvature is the reaction to spacetime density. This makes the space dimension longer and the time dimension shorter. For anti-gravity, we have to reverse this. The space dimension must become shorter and the time dimension longer. This happens for two reasons:

- Spacetime is a continuum
- Spacetime has the higher-dimensional limit with the dimensional constant d

Spacetime is a continuum. This means that there is no boundary between spacetime density and spacetime curvature. They merge directly into one another. This is not a problem as long as the difference between spacetime density and spacetime curvature is not too great. The problem arises when we want to move from extreme spacetime density to extreme spacetime curvature. We have no problem with the time dimension. In both cases, the time dimension becomes shorter, and we already have a suitable transition. It is different with the space dimension. It becomes smaller with spacetime density and larger with spacetime curvature. Above a certain difference between these behaviors, the difference is greater than our dimensional constant d, which allows for change within a certain length. That does not work. There must then be a range between the spacetime density and the spacetime curvature where this continuously adjusts. We get anti-gravity from the spacetime curvature to the spacetime density. The spatial dimension becomes smaller and not longer. Since the time dimension also has to adjust, but actually already has the appropriate behavior, this adjustment is also only possible within a certain length.

We obtain anti-gravity shortly before the "singularity." This is the desired behavior according to the field equation, and we now also know why this is the case. However, this only happens when we get close to d. The greater the spacetime density, the greater the area of transition with anti-gravity. We will not be able to detect anti-gravity in our solar system.

5.9 The gravitational potential

The final act for this chapter will be gravitational potential. In my opinion, the term "potential" is one of the least understood but most frequently used terms in physics for calculations. If it does not have to be 100% accurate, then we always calculate problems involving gravity using potential rather than directly using spacetime curvature. Otherwise, it is far too complicated. The trajectories of almost all objects that we have launched into space and will launch in the future have been calculated in this way.

If we ask a physicist what potential is, we almost always get something along the lines of: Potential is the ability to convert potential energy into kinetic energy. Okay, where does this ability come from? Is it inherent in the body? Everyone agrees that this ability lies in the potential and not in the body. The identical body outside of a potential does not experience acceleration. So, what is this ability? Usually, there is a pause. Often the answer is: a property of the potential. We are back to square one.

For almost all potentials, it is important whether the test body participates in the interaction of the potential at all. A neutral neutrino is completely unaffected by an electric potential. With gravity, we have the peculiarity that absolutely everything we can identify as an object participates in the gravitational potential. This makes sense, since in DP everything is a spacetime density in curved spacetime and must therefore participate. With the other interactions, the geometry in QM determines whether an interaction may take place.

We have another special feature. The "internal structure" of the object with the appropriate charge for the potential is irrelevant. Whether an electron as an elementary particle with an elementary charge of 1 or a composite proton that is almost 2000 times heavier with an elementary charge of 1 participates is irrelevant for the effect. It is only about the elementary charge of 1. In gravity, however, particles that have no charge, in this case no mass, also participate, e.g., the photon. It is about the deviation of the length dimension from the time dimension. This is always zero in spacetime density, since the space and time dimensions deform identically. The deviation comes solely and exclusively from the environment with spacetime curvature. This will also be the case for other potentials, such as the electric field.

If we want to get out of a gravitational potential, we have to counteract this acceleration. We need a rocket. The acceleration is not just an apparent effect. A rocket must deliver sufficient power to successfully counteract this acceleration. This time, we apply a force to the rocket via interaction, which actually increases the spacetime density. The state of motion of the spacetime density (rocket) and thus the energy itself must be increased to escape velocity by acceleration.

Acceleration converts kinetic energy into potential energy. This is the classic statement about gravitational potential. In fact, nothing is converted into potential energy. The rocket must generate acceleration against gravity through interaction. The rocket leaves the gravitational potential and then has a higher state of motion outside the potential.

Calculating the potential is very simple. Energy conservation results because the mutual accelerations must cancel each other out. The energy of the rocket has actually increased. The potential is simply assigned to negative energy. However, the object, our rocket, has actually increased its spacetime density when leaving the potential. This is all lumped together in the calculation. Negative energy in the potential gives us energy conservation and the calculations are very simple.

How does this work in the special case of light? Let's look at a photon in the wave description, as this is somewhat simpler. The photon does not necessarily have to slow down; it can do something else. If the energy of a photon is determined by its wavelength and acceleration corresponds to an increase in energy, then the photon can increase its energy at the same speed by means of a smaller wavelength. This is the blue-shift. If the photon wants to escape from the gravitational potential, the opposite happens and we get the red-shift. It has to use part of its existing spacetime density to counteract the acceleration of gravity. However, this only works into or out of the potential.

This clarifies where the equivalence principle comes from. To summarize again in a few short sentences:

- Spacetime density always has an identical change in its space and time components. Therefore, the first axiom applies to all objects in our universe.
- Spacetime curvature always has an opposite change in space and time components.
    - Spacetime density does not change in a spacetime curvature.
    - This means that it cannot change its state of motion itself.
    - The ratio of spacetime density to spacetime curvature remains identical (area).
    - In order for the state of motion **to remain identical** (there is no external interaction), for example 1m/s, a spacetime density in a spacetime curvature must undergo acceleration.
- Since everything consists of spacetime density, everything must also participate in gravity.
- Since light cannot accelerate further, a redshift, a blueshift, or a Shapiro delay must occur.
- The higher state of motion is simply evaluated as negative energy (spacetime density = state of motion = energy) from the perspective of potential. This means that the total energy remains identical. The spacetime density has not been changed.
- If a graviton or other exchange particle for gravity is ever discovered, the DP will be falsified.

This brief explanation should now make it clear why Lagrange and Hamilton work so well. It all comes down to the conservation of energy. Spacetime density can only transform itself. Spacetime density cannot decrease or increase itself; this is the conservation of energy. With this knowledge, we can turn our attention to cosmology: the evolution of our universe.

6 Cosmology

This concerns the development of our universe. It is all based on the new view of DP on GR. For cosmology, we will have to extend GR to higher- and lower-dimensional spacetimes. We define that the term "universe" always encompasses all these spacetimes. A spacetime is only a specific spacetime configuration. The universe is a collective term for everything.

In cosmology, we will connect the spacetimes across the dimensional boundary to form a universe. This means that our universe is not fixed to one spacetime, but rather to recursive spacetimes. We will show that each of these spacetimes is a potential field in itself.

We can specify what the Big Bang really was, but we cannot determine its true origin. We can specify an object for dark matter that is necessarily created in a kind of inflationary phase, but which is not a new elementary particle. Dark energy is no longer needed.

Here, too, there is a fundamental question that is too rarely asked, in my opinion. Why is our spacetime expanding? Unfortunately, the word "Big Bang" contains the word "bang." Doesn't that clearly imply that the object must also expand with the "bang"? We will see that this has nothing to do with a bang at all. Is it spacetime or, as described in textbooks, only space that is expanding? The field equations of general relativity show that a static universe does not work. General relativity does not allow for a static universe. Yes, but mathematics does not force any object to do anything. There must be a reason built into this mathematical model.

In addition, we will learn about further "deformations" of spacetime in this chapter. The picture is not yet complete. These deformations are not possible at all spacetimes. This depends on the number of spatial dimensions. We need all these ingredients to build a clean and closed picture for GR and the universe itself.

More importantly, we need to understand the concept behind cosmology well. The reason may be somewhat surprising. The concept developed here in cosmology, beyond dimensional boundaries, is the basis for quantum mechanics (QM). QM is a form of low-dimensional cosmology. QM cannot be understood without cosmology.

6.1 Recursive Universe

We have an approach with spacetime density and spacetime boundaries. Therefore, every n-dimensional spacetime volume has an infinite number of lower-dimensional spacetimes and at least one higher-dimensional spacetime. We will look at how these affect the different numbers of spatial dimensions. This approach will make it clear that QM and cosmology go hand in hand. Let's keep it simple again and start from scratch.

6.1.1 Spatial dimensions 0

This is very easy for us. We already discussed this in relation to the boundaries of spacetime. That was the discussion with the mathematical abstraction of a point. There can be no spacetime without a spatial dimension. That's it. Spacetime without a spatial dimension will not be discussed further.

6.1.2 Spatial dimension 1

If we have one spatial dimension, then we always have a time dimension as well. Thus, a spacetime. In DP, there can only ever be one time dimension in a spacetime configuration, as this is the measure of distance to the spacetime boundary.

The problem with only one spatial dimension arises from GR. This cannot be represented in a spacetime with only one spatial dimension. The aim is to determine the deformations of the space and time components in relation to each other. With only one spatial dimension, no spacetime curvature can be determined. GR only starts with two spatial dimensions. Even if we could have a density and a curvature purely logically in only one spatial dimension, there is no low-dimensional spacetime for it. There can be no rest mass or elementary particles, since there can be no low-dimensional quantum mechanics. We have ruled out spacetime with zero spatial dimensions. However, these are the sources of spacetime curvature. Result: In a spacetime with only one spatial dimension, there can be no representation of spacetime density or spacetime curvature within this spacetime.

Does that rule out 1D? No, not quite. For us, 1D is usable and must be so. Contrary to GR, we can work with extrinsic characteristics. Extrinsic deformations have no effect in their own spacetime. We obtain a higher spacetime density in 2D when 1D has an extrinsic characteristic. In 2D, there is more 1D spacetime. This is identical to the discussion with the photon. Only one spacetime configuration deeper.

Figure1: Shows an extrinsic manifestation as a wave in 2D (Sting)

We will need this again in Part 3 for the description of neutrinos. In cosmology, it is important for us that a 1D spacetime cannot have a representation of a spacetime density and thus a spacetime curvature for itself. There can be no development within spacetime in 1D. Cosmology is not possible within 1D.

6.1.3 Spatial dimensions 2

In 2D, we are "almost happy" from the perspective of GR, but only almost. We can map many things from GR in a 2D spacetime, with two crucial limitations:

- In scientific terms, there is a lack of freedom for spacetime curvature to propagate through space. In layman's terms, everything is fixed. In 2D, there is no possibility for change in the curvature of spacetime and thus also in the density of spacetime. Things like gravitational waves do not work at all. Another spatial dimension has to be removed, leaving us with 1D, where we cannot depict anything.
- To depict a black hole, we need what is known as anti-de-Sitter (AdS) spacetime. This is a spacetime in which the curvature of spacetime is always constant and the spatial extent is infinite at all times. This fits in with our first point: everything is fixed. Our spacetime is de Sitter spacetime, i.e., a spacetime with a non-negative cosmological constant.

We often imagine 2D as our 3D spacetime "squashed" onto a surface. This idea is completely wrong. No planet, no sun, no galaxy, and no life can form there. Something is either statically present or not. There are only three possibilities for a representation:

- We can obtain a static extrinsic mapping as in 1D, e.g., a photon.
- We can map a static black hole, e.g., an electron. With the restriction to a so-called anti-de Sitter spacetime. This becomes important again during expansion.
- A spacetime density in 2D via the extrinsic 1D spacetime density

That's all there is. This is not only a restriction from GR, but also from the limits of spacetime. The reason for this is simple. We do not have low-dimensional QM available in 2D. In order to be able to map elementary particles, QM must be available. In 1D, we only have the option of extrinsic mapping of a spacetime density in 2D. This gives us neutrinos. We have reached the end of the line. In 2D, we can only map neutrinos as elementary particles. Further representations of a spacetime density can only exist without a low-dimensional QM. We already had this with the limits of spacetime. Only a black hole is a spacetime density without a low-dimensional representation. Cosmology is the development of spacetime. A black hole in 2D cannot have any development because everything is static.

2D is therefore also out of the question for cosmology, as there is no development. In particular, 2D spacetime is very different from our 3D spacetime. The fact that 2D is completely static will benefit us later in QM.

Here is a small side calculation using the classic image of physics. We have Newton's formula:

$$F = \frac{G * m_1 * m_2}{r^2}$$

This results in a force and thus a change in spacetime density. The units of measurement are:

$$[m * a] = \left[\frac{l^3 * m^2}{m * t^2 * l^2}\right] = \left[m * \frac{l}{t^2}\right]$$

In 2D, we have to make the following changes with our logic.

- The fraction must not contain r^2, but only r. A force that depends only on distance always decreases by n-1 in n-dimensional spacetime. Therefore, in 2D, only r remains.
- The G is the G for 3D. In 2D, a c must be removed from our definition, as the speed of light is present in each dimension.

This results in the following for G:

$$G_{3D} = \frac{l_{P\ in\ 3D} * c^2}{m_P} \Rightarrow G_{2D} = \frac{l_{P\ in\ 2D} * c}{m_e}$$

This results in the gravitational force in 2D with the units of measurement:

$$\left[\frac{l^2 * m^2}{m * t * l}\right] = \left[m * \frac{l}{t}\right]$$

This is no longer a force, but only momentum. Thus, there is no acceleration and no change in spacetime density. Everything remains static.

6.1.4 Spatial dimensions 3

We have finally arrived at our spacetime. We will see that 3D spacetime is something very special. We have two features from 3D that are "vital" to us.

- From 3 spatial dimensions onwards, development within a spacetime is possible. If there is one characteristic of life that we can describe as the most important, then it is evolution. Without evolution, there is no life. Cosmology is the evolution of spacetime. Since everything is spacetime, life can only exist from 3D onwards.
- However, evolution is not simply change. Evolution is change based on stable steps. In order to have individual steps/objects, or rather elementary particles, we need low-dimensional QM. This is also only possible in 3D, as we only have a low-dimensional representation in 2D spacetime. All representations in 2D are static. We can only determine the various possibilities of a 2D representation in 3D when we take a

measurement. The individual possibilities (states) that are available for selection are also static in QM. Only the mixture or selection of possibilities remain open until the measurement is taken. Without this static foundation, there would be no QM as we know it.

With these brief considerations, it should already be clear that life, as we can define or understand it, exists only and exclusively in 3D spacetime. Since the rest of this chapter deals almost exclusively with our 3D spacetime, we can end this description here.

6.1.5 Spatial dimensions 4

We cannot stop at 3D. We have black holes in our spacetime. These are a transition to a higher-dimensional spacetime. This makes us certain that our 3D spacetime is embedded in at least one 4D spacetime. That is both the good news and the bad news. Good, because it provides an explanation for the Big Bang. We will describe the Big Bang in the next section. The bad news is that this opens Pandora's box. We are left with two major problems.

6.1.5.1 An infinite number of 3D spacetimes

We have established at the boundaries of spacetime that every n-dimensional spacetime volume must have an infinite number of (n-1)-dimensional spacetimes. If there is at least one 4D spacetime, then there are also an infinite number of 3D spacetimes. If we look for an explanation for experimental findings from the cosmos, we get a new huge solution space. The 3D spacetimes could influence each other. If we look for a "culprit" for dark matter or dark energy, we can certainly build something from an infinite number of 3D spacetimes.

We do it here like GR. There, for reasons of economy, no higher- or lower-dimensional spacetime was explicitly assumed, and everything was placed in 3D spacetime. We will adhere to this principle when considering possible solutions. The first attempt at an explanation should always come from our spacetime. Only when there is no other option do we resort to the infinite number of other 3D spacetimes or to 4D spacetime.

6.1.5.2 QM from 4D

If there is a spacetime with four spatial dimensions, then we simply need to increase our mathematics by one spatial dimension, and we can then calculate everything again in 4D. This still works with general relativity. Everything becomes a little more complicated, but it is possible in principle.

With QM from 4D, the fun stops. QM from our spacetime is already very complicated. It is just about manageable for two reasons, if one can say that at all.

- The mathematics is linear
- The individual possibilities are fixed. Only the mixture or selection of the fixed possibilities is subject to probability.

A QM from 4D has 3D as its low-dimensional substructure. In 3D, there is an evolution of images in spacetime. Nothing remains fixed. The possibilities of the images in our 2D QM are only extrinsic manifestations and black holes. In 3D, there is everything that can be seen in our universe. QM from 4D must be incredibly complicated. In addition, black holes form in our spacetime. These are again a connection in 4D. This is the reason for the physical and mathematical worst-case scenario.

This is so far removed from anything I can imagine that I will leave it alone. This makes 4D as a solution completely unsatisfactory. However, we will at least shift one solution approach to an area that we cannot investigate. This is not really a solution, but merely a "shift." However, DP dictates this path.

6.1.6 Termination of recursion

Of course, we cannot stop at 4D. Mathematically, recursion can go on indefinitely. How many spatial dimensions are there then? I do not know.

But we can make an estimate. If we want to have a QM mapping from an n-dimensional spacetime to an (n-1)-dimensional spacetime, then the spacetime density in the n-dimensional spacetime must not be a black hole. It follows that the total spacetime density of our 3D spacetime in 4D is not sufficient for a black hole (further discussion of this in the next section on the Big Bang). We must be a quantum of spacetime from 4D and not a black hole. Our 3D spacetime started as a 4D spacetime density.

In our spacetime, the Planck mass is the criterion for a black hole. The simplest representation of a black hole in 2D is an electron (Planck mass in 2D). The difference between 3D and 2D is already approx. 10^{22}. The universe has a total mass of approx. 10^{57}kg. The Planck mass in our spacetime is only 10^{-8} kg. The difference between 3D and 4D must therefore be at least approx. 10^{65}. This value increases extremely rapidly with each spatial dimension in a spacetime. If there is no longer enough spacetime density in a spacetime to represent the Planck mass, the recursion breaks down. I do not believe that we can escape from the single-digit range of spatial dimensions. We will learn shortly in the section on the Big Bang that our universe actually started with a much smaller mass. We make a mistake in extrapolating the mass in the universe if we believe that all the mass detectable today must have already been present at the time of the Big Bang. The error is particularly significant in the case of black holes.

6.2 Big Bang

We have gathered enough information to almost resolve the Big Bang. We cannot quite manage it because we have to "shift" the Big Bang into the realm of unsatisfactory solutions. We will definitely need 4D here. Let's describe a Big Bang in 3D spacetime. We will see that a Big Bang has a lot to do with QM.

There are three fundamental problems with the Big Bang as described in textbooks.

- We start with spacetime at Planck length and extremely high energy. The actual process of creation of the starting point or spacetime is missing. Where does the Planck-sized spacetime, the energy, the fields, etc. come from? The Big Bang is a process. Where do the objects for the process come from?
- The Big Bang is said to have started from a fluctuation. We will leave aside the discussion of which field it might have been. Some kind of fluctuation is needed. Where should it come from if we cannot yet define the passage of time? Fluctuation without a definition of time and space?
- If a fluctuation or symmetry breaking in a field of QM is supposed to have triggered the expansion of spacetime, then this field must be coupled with spacetime in some way. A field undergoes a change and spacetime begins to expand. There must be a coupling. What does it look like?

There is no answer to any of these questions in the textbook. The development of the universe is simply (here far too simply) calculated back to Planck time and Planck length. Spacetime, energy in spacetime, fields, fluctuation, coupling of fields with spacetime, etc. must then simply be present. We do not want to start our universe this way.

6.2.1 What doesn't work

Let's try everything we have so far:

- 0-space dimensions do not exist
- 1-dimensional space has no representation
- Two-dimensional space is static, so no fluctuation or initial spark is possible

In fact, we also have to start with 3 spatial dimensions in the Big Bang. However, with only 3 spatial dimensions, we are in the same situation in DP as in textbook physics. Once again, we cannot answer the 3 questions. 3D spacetime is simply not enough for this. The textbook covers various fields. We have to resort to something else. Unfortunately, there is only one option left: the unsatisfactory 4D solution. Let's try to solve the three questions.

6.2.2 QM for 4D spacetime as a process of creation

As always, DP guides us in the right direction, as there are almost no other options. In order to obtain a spacetime density in an n-dimensional spacetime, there must simply be a spacetime density in an (n+1)-dimensional spacetime. Since the spacetime density represents spacetime itself, this "low-dimensional mapping" is a genuine creation of spacetime.

This makes it clear:

The Big Bang is a mapping of a 4D spacetime density as QM there onto a 3D possibility.

We exist in one of the 3D possibilities.

I know that this is not very spectacular for a Big Bang as a divine act of creation. However, within DP, this is the only possibility we have.

When we look at our bodies, we could previously view ourselves as almost divine beings. Every single elementary particle of our body, and there is a hell of a lot of them, has an infinite number of representations in low-dimensional space-times. We are made up of an infinite number of 2D and 1D spacetimes with black holes. Simply wow! Now comes the damper. From the perspective of a 4D spacetime, what are we? The best description is probably "nothing." Our universe as a whole is an arbitrary spacetime density there. Whether there are elementary particles there, etc., I have no idea. As I said, that's where I stop. QM in 4D has to be solved by smarter people. Only a black hole in our spacetime creates an effect in 4D again. Everything else is irrelevant for 4D.

What we can do is rule out one important possibility. We cannot be a black hole in 4D. Otherwise, there would be no lower-dimensional representation of this spacetime density. Since our universe exists, this is impossible. The same argument applies to the recurring idea that our universe is a 3D black hole, and we are at the center of the black hole. Even then, the spacetime density should not have a lower-dimensional mapping. I am sure that we are subject to QM.

Sorry that the Big Bang is so simple. Just a recursive image of spacetime density. We can now specify exactly what the Big Bang is in our spacetime. But we haven't solved the basic problem. It has simply been shifted from 3D to 4D. Where does the spacetime density in 4D come from? I have no idea. I can't even say whether we are just one possibility in 4D or whether we count as something real in a measurement there. I admit that this solution is very unsatisfactory. But it's the only one we have.

6.2.3 Fluctuation in Planck length and Planck time

For the "initial conditions" of the Big Bang, textbooks assume the Planck length and Planck time. Why is that? Presumably, it is assumed that there is no smaller length or time in our universe. When calculating the size of the universe backwards, one must stop here at the latest. Are

Planck length and Planck time really good assumptions for the starting condition of the universe? Not for DP. There are two reasons for this:

- With these sizes, it is no longer possible to have a fluctuation, even in the DP. This means that the desired spark from the textbooks cannot have existed.
- We can do a small calculation for the starting size

6.2.3.1 Planck length and Planck time as lower limits

Like GR, we assume continuous spacetime. There must be no smallest values for time or length. Otherwise, we would not have a continuum. Where does this lower limit come from?

In DP, Planck length or Planck time have no relevance on their own. It is the values we use for c, d, and h. However, these values always occur in combination. This combination of values is crucial. Thus, these are not the smallest units of space or time.

Where quantum physics and the textbook approach are identical is in the Planck length and Planck time as the smallest barriers for interaction. If you want to have limited interaction in these areas, then so much energy is required that the value of *d* is exceeded, and it goes into a black hole. Both theories agree that there must be no interaction of any kind in this area.

Let's ignore the origin of spacetime and fields from the textbook approach in the Big Bang for now. We want the Big Bang to arise from fluctuation, symmetrical breaking, or something similar, as desired, but this is not possible with Planck quantities. Space and time are not defined at this level. How can an interaction in space and time take place there?

I understand that a lower limit is needed and, for lack of anything better, this one has been drawn up for now. Sorry, but that just doesn't make sense. Can we specify something better in the DP?

6.2.3.2 Starting size of the universe

We cannot calculate the initial size exactly. However, we can make an estimate again. Our approach for calculation is d, the dimensional constant. We are certain that our universe did not start as a black hole. Therefore, the spacetime density cannot have been too large. This allows us to specify a minimum size for the distribution of energy at the Big Bang, which cannot be undershot. We make the calculation a little simpler and not 100% accurate, as it is only an estimate. We take the reciprocal of d, which makes it a little more obvious.

$$\frac{E_P}{l_P} > \frac{E_V}{l_{wanted}} \rightarrow l_{wanted} > E_V * d$$

E_V is the energy of the vacuum. We assume that the reciprocal of d must always be greater than the right side. If the fraction on the right side is greater than or equal to the left side, a black hole would have to form. Then we substitute everything:

Energy in the vacuum approx.: $7.67 * 10^{-1}\ Joule/m^3$

d : $8.26 * 10^{-45}$

$l_{wanted} > 6.338 * 10^{-5}$

Oops! That's smaller than the Planck length. We have also simply applied the energy from a volume to a length. We have to estimate the size for each spatial dimension. Our entire spacetime starts out small.

$$l_{wanted} > \sqrt[3]{6.338 * 10^{-54}} \rightarrow l_{wanted} > 1.85 * 10^{-18}\ Meter$$

That is still very small as a lower limit. A proton is approx. 1000 times larger. However, the starting point is already 17 orders of magnitude away from the Planck length.

6.2.4 Coupling of fields and spacetime

For me, this is one of the most important topics in cosmology. It is also one reason for accepting DP with spacetime density and spacetime boundaries. How can the fluctuation or symmetry breaking of a QM/QFT field influence spacetime?

Spacetime (or just space) is expanding. What about the fields? Do they cause spacetime to expand? If so, then there must be a coupling. If not, then these fields cannot expand with spacetime? Were they already present in infinity? Then the Big Bang only affects spacetime and no QM/QFT fields? If field fluctuations in the fields are to trigger something, then there must be a coupling. The only known coupling is GR. However, this is not supposed to have anything to do with quantum fields.

We can ask endless questions, but it always boils down to the fact that the fields of QM/QFT must have a coupling with spacetime. Otherwise, these fields would simply not trigger anything. I have never seen a description of this. This is a huge construction site in QM/QFT (not quantum gravity), but no one is working on it.

In DP, we have an easy job. All fields of QFT are low-dimensional spacetime configurations. Low-dimensional spacetimes only arise with the mapping of spacetime density from higher-dimensional spacetime. These fields did not exist before the Big Bang. Therefore, there cannot be any fluctuation in our case.

The limits of spacetime imply that geometric concepts such as size, length, etc. do not exist between 2D and 3D. Whether 3D spacetime expands is irrelevant to 2D spacetime. The coupling we know of are the particles of the Standard Model. This is the only possible mapping of spacetime density across the boundary. An electron shortly after the Big Bang, shortly before the speed of light, or on its way to the center of a black hole is always an identical electron. The electron does not care what drives higher-dimensional spacetime. It only has to be the mapping of a spacetime density.

In DP, the QM mapping for the Big Bang is not relevant for our 3D spacetime in the first step. However, the Big Bang is a 4D QM/QFT mapping in 3D. This is how spacetime is actually created. Our entire universe is probably just a 4D elementary particle.

The dimensional transition via spacetime density is the only coupling of the different spacetimes to each other.

6.3 Why expansion?

Let's move on to **the fundamental question of cosmology**. Why is the universe expanding, and what is actually expanding?

Don't come at me with: "The Friedman equations from general relativity determine that there is a scale factor for space (not spacetime). This means that the universe must expand." No, no, and no again. Mathematics describes nature. Mathematics is not a "force" of nature that can produce an effect. If such a statement is made based on a description, then there must be a physical reason for it. This is built into the mathematical model.

What is the reason? The answer in textbook physics is very simple: it is not known. Unfortunately, this answer is given too rarely. The mathematics of GR is always used as an argument. Dark energy is only there for later exponential growth. For the first billion years, let's say, it played no role in the expansion. We need expansion immediately with and after inflation. Yes, exactly, we also need inflation so that the observations match. Then there is dark matter and dark energy, etc.

The observation of expansion and the scale factor from the Friedman equations fit together so nicely that the entire cosmology has been built on them. We already have the Big Bang, so the rest could be identical. We will show that the descriptions are almost identical from a certain point of view. However, we will use completely different foundations in DP.

For this reason, we will make a change in the structure of the text. Until now, we had first or simultaneously built up the classical view from the textbook together with DP. This makes the comparison easier. That no longer works here. We will first build up cosmology from the DP perspective. Later, we will compare this with the classical view. The approaches are too different. This means that the basis of cosmology from the DP perspective will seem a little strange to professionals in cosmology. Example: In the DP, spacetime changes and not just space. We will see that this is also the case with the Friedman equations. It is just very well hidden. For a complete picture of cosmology, Chapter 6 must therefore be worked through completely in the given order. The reference to textbook physics only comes at the end.

6.4 Expansion of spacetime

Let's ask again: Why does spacetime expand? This question is very easy to answer in DP. Simply because of the existence of spacetime.

- Every spacetime point has a spacetime density
- Spacetime density is energy, geometry, and **state of motion** all in one. This is an identical property with different descriptions.
- There does not have to be a particle for there to be motion. Even a spacetime point in a vacuum must have a state of motion.
- This means that all spacetime points must have a state of motion relative to each other. The distance must increase or decrease.
- This state of motion must not have a specific direction. It must be a state of motion in all directions simultaneously.
- A simultaneous movement of spacetime itself in all directions corresponds to spacetime expansion. A spacetime point has a "scalar" movement.

The chosen approach necessarily implies that spacetime can never be a static structure in itself. We do not need to search for the reason why. Conversely, without spacetime expansion or compression, the DP approach makes no sense.

6.4.1 Known changes in the components of spacetime

If a spacetime point is a state of motion, it is not yet clear how the spacetime components must deform. So far, we have two deformations, one for spacetime density and one for spacetime curvature:

- For a rest mass, there must be a scalar spacetime density = first part of the energy.
- For momentum, there must be a vectorial spacetime density = second part of energy.
- For the continuum of spacetime, the spacetime curvature must balance the spacetime density. No energy change in spacetime = gravity.

Let's look at the available options to see if we can use them for expansion.

6.4.1.1 Scalar spacetime density for particles

Scalar spacetime density sounds very good indeed. This is exactly what we are looking for expansion. But we have a problem. This scalar spacetime density for a mass-energy equivalent is defined by the fact that the energy is higher than in the surrounding area. This makes the time and space components shorter to the same extent. The definition of length becomes smaller. We need an enlargement, that is the observation. So, this is not so wrong. Only the direction is wrong. This means that expansion could be the counterpart. An enlargement of the definition of time and length.

But the next question immediately arises. If spacetime density must necessarily expand scalarly, why doesn't a mass-energy equivalent do the same? In principle, there is no difference between an elementary particle and the entire spacetime in the Big Bang in terms of spacetime density. However, the elementary particle does not expand. We are very sure of that. Where is the difference? Fortunately, there is a spoilsport and an exception. In this section, we will only discuss the spoilsport. We will make the exception for redshift.

The spoilsport is QM. Every spacetime density from 3D onwards has a lower-dimensional representation. This representation knows no geometric information such as "size" beyond the dimensional boundary. The mathematical representation in QM is actually something like a point size when viewed in 3D. 3D spacetime is now no longer independent. It can no longer change the spacetime components as it pleases as long as QM has a fixed mapping. We absolutely need interaction so that the mappings of spacetime can be divided differently in QM. Without interaction, everything remains fixed. The mappings in 2D, with the particle zoo from the Standard Model, hold our spacetime together.

6.4.1.2 Vectorial spacetime density for particles

This is the same as above, except that the spacetime density is mapped to a specific spatial dimension (direction). The big difference is that the momentum is a mapping in 3D. This is explicitly not protected by the mapping in QM. We can see this behavior in neutrinos, for example. These particles are stable and were produced in large quantities in the early phase of the universe. Neutrinos are still measurable today. However, the momentum of these neutrinos has decreased due to expansion.

Here is another comment on motion. Momentum is explicitly a vectorial spacetime density. Only this can be perceived as motion in spacetime itself. In order for us to perceive a particle, we first need the scalar spacetime density. The motion of the particle is then the additional vectorial spacetime density. Therefore, expansion must be a scalar spacetime density. Nothing moves relative to spacetime, but only with spacetime.

The vectorial spacetime density is the inverse case of the scalar spacetime density for expansion. The inverse case of momentum is negative momentum. Is expansion then supposed to be deceleration? A loss of energy for spacetime? As you can see, it remains exciting. The resolution will come later in this chapter.

6.4.1.3 Spacetime curvature

With spacetime curvature, the definition of length increases and the definition of time decreases. The greater length looks good at first glance. Why not gravity? The changes in the components of gravity are out of the question for two reasons.

Spacetime curvature is not a reaction of spacetime to itself. For spacetime curvature, we absolutely need different spacetime densities. Gravity reacts to this. If you like, spacetime curvature is a passive reaction. An imbalance must first be created, for example through QM. When directly mapping 4D to 3D, there is no reason to assume that spacetime was not completely homogeneous. 4D would not experience any fluctuation in 3D. Immediately after the Big Bang, the spacetime curvature in our spacetime should have been zero. Therefore, no expansion results from gravity.

We can rule out the second reason based on observations. Gravity is always directed toward a center and decreases with distance. According to observations, we need expansion that is nearly identical throughout the universe. This cannot be achieved with any interaction whose effect depends on range.

6.4.2 New changes in the spacetime components

We would have arrived at a similar result if we had looked at the possible changes in the spacetime components in an overview. There are only time and space components. These can only increase and decrease. The number of possible combinations is small. We expand the first overview of the deformations:

Figure2: Overview of deformations

Deformation	Deformation
Spacetime curvature/gravity • **Time dilation** • **Length relaxation** • **inhomogeneous**	**Spacetime density** • **Time dilation** • **Length contraction** • **homogeneous**
Anti-gravity • **Time relaxation** • **Length contraction** • **inhomogeneous**	**Expansion** • **Time relaxation** • **Length relaxation** • **homogeneous**

We have the known deformations. However, there may also be a counterpart to each of these. In physics, the counterpart is often referred to as "anti." Therefore, we refer to the counterpart to gravity as anti-gravity and the counterpart to spacetime density as expansion. Please do not refer to it as anti-spacetime density.

We do not allow certain types of combinations. If there is a change in a space component, then there is also a change in the time component and vice versa. We do not allow the possibility of a change in the space component without a change in the time component or vice versa. A change in the definition of length is always a step toward or away from the spacetime boundary. Since time is the measure of distance to the spacetime boundary, within DP, a change in space and time always works together. If we have learned anything from SR and GR, it is that spacetime should be regarded as a single substance. The components change together with equal intensity or not at all. An expansion that only involves space but not time is not possible for us. This once again puts us at odds with the current doctrine on expansion. The resolution comes later and is surprisingly simple.

What we can easily see in the above list is that gravity is not the counterpart to expansion. This is often explained incorrectly. Gravity only ensures the continuum in spacetime. Gravity does not care about expansion or contraction. It only reacts to fluctuations in spacetime density. However, it does not explicitly change the spacetime density. If spacetime density changes homogeneously without fluctuation, there is no gravity or anti-gravity.

This makes it clear what increases during expansion. The definition of length and time becomes larger. Even during expansion, there is no squeezing or pulling. At every point in spacetime, the definition of length and time is enlarged. This leads to greater distances. We cannot detect the change in the definition of time because it does not add up over a distance. We will do this at the end when we compare it with textbook physics.

Wait a minute. If this happens identically everywhere in the universe, then I wouldn't be able to detect this increase. Almost correct. However, the elementary particles that make up everything do not participate in this. QM does not allow this. This means that spacetime becomes larger and larger in relation to an object. In addition, we measure this from a gravitational field. Gravity is not the counterpart, but it does resist expansion. Expansion wants a larger definition of time, gravity a smaller one. QM and gravity increase the resistance to expansion.

6.5 Process of expansion

We now have all the pieces together to describe the process of expansion. In doing so, we will find that a form of matter must explicitly form, namely dark matter. These only forms when spacetime behaves in a certain way, namely inflation. Since dark matter is created, inflation in DP looks different than in textbook physics.

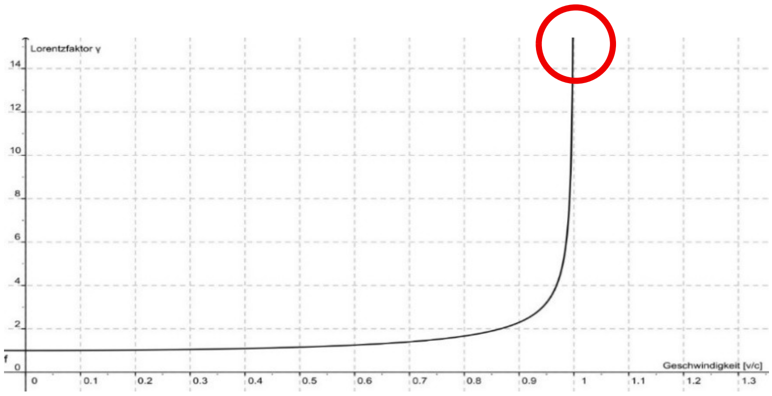
6.5.1 The Big Bang as the starting point

We have already covered this. A 4D spacetime density is mapped onto our spacetime. This creates our spacetime. The spacetime density is completely homogeneous. The mapping is below the dimensional constant, otherwise a black hole would form. We have already made an estimate of the size. This means that spacetime still starts with an extremely high spacetime density. Then spacetime expansion begins. QM actually needs some time. This means that expansion starts before QM.

6.5.2 Inflation

In DP, inflation is a necessary prerequisite for the start of expansion. There is no additional field, there is no fluctuation, there is no symmetry break, there is no ... (think of any name you like, it has certainly been used before). Nevertheless, there is exponential growth in the definition of length. The solution is very simple. Let's take a look at the graph.

Figure3: Inflation as a reversal of length contraction



This is the illustration of length contraction and time dilation (Lorentz factor) from SR. The solution must already be contained within SR in DP. Gravity is only the compensation for a fluctuation in spacetime density. We don't have that at the Big Bang. So, the reason for the expansion must already be contained in SR. We just have to reverse the direction. We need time relaxation and length relaxation. The Big Bang is the starting point. That is the red circle. Somewhere far above. Whether a 3D spacetime starts with an inflation phase depends solely on the amount of spacetime density represented by 4D.

We do not need any further "vacuum conditions" for inflation to stop again. Everything happens automatically here. The entire process of inflation is already contained in SR. However, inflation itself is a different process here than in textbook physics. Contrary to textbook physics, we do not need inflation at all to solve certain problems. Flatness of spacetime, horizon problem, etc. We do not have these problems at all with the initial condition of homogeneous spacetime density. Nevertheless, inflation is still there and cannot be avoided in a 3D spacetime with so much spacetime density.

6.5.3 Dark matter

Something unexpected happens during inflation. Black holes are created. Not just any black holes, but the smallest possible black holes. But let's take it one step at a time.

6.5.3.1 Spacetime is a potential field

Spacetime expands. This causes an energy change in spacetime. Spacetime "thins out." According to our logic, this means less energy. Nothing changes for spacetime itself. A meter remains a meter because the definition changes. It follows that there is no local change in energy for spacetime. The energy simply has to be distributed over a larger volume. The content thins out, but the total amount does not change. Thus, the DP implies energy conservation for the entire spacetime with expansion. The spacetime density only transforms.

Due to QM, an elementary particle will not participate in the extreme dilution during the inflation phase. Then the energy of the particle will increase exponentially. This is like the equivalence principle. No interaction from outside, but still a change. In the case of gravity, this is due to the opposite deformation of space and time. Thus, without an change in the energy conditions. Here, however, space and time become uniformly larger. The elementary particle gains energy because the valence of the spacetime density of the elementary particle changes in relation to its environment. We have called this a potential field. Here, directly for energy.

Spacetime is a potential field for energy.

6.5.3.2 More energy until the black hole

This means that every elementary particle in the inflation phase that does not decay quickly enough receives an exponential increase in energy. However, this only goes up to the dimensional constant. Then a black hole forms, with the exact Planck mass. This gives us the smallest possible black hole that can form in our spacetime. Once the exponential growth of the length definition is over, this can no longer happen.

If spacetime is a potential field, black holes must necessarily form from the first stable elementary particles in combination with inflation. The inflation phase does not last very long. The reason is simple but also surprising. With length contraction and time dilation, there is a maximum speed, the speed of light. Space and time dimensions cannot go below zero. In the opposite direction, there is no maximum limit. Expansion is very rapid at the beginning. Only the onset of quantum mechanics and gravity slows it down.

6.5.3.3 Dark matter = black holes

These smallest black holes have a very special property. Their cross-section is close to zero. A quick calculation shows that a black hole with Planck mass has a Schwarzschild radius of 2 Planck lengths. That is incredibly small. It is so small that absolutely no particle from the Standard Model can fit into the black hole in one piece. If such a black hole wants to consume something, it must be able to take in an elementary particle as a quantum (in one piece).

These are black hole corpses. They cannot do anything with matter. This means that black holes remain what they are from the moment they are created. These black holes therefore have the following properties:

- They are present from the beginning
- Cannot change over time
- Only interact via gravity
- Show no other properties than gravity
  - There is no radiation or anything similar. Even Hawking radiation would not work here, as the black hole would have to be able to consume a particle for this to happen.

- Even if two of these black holes merge, no radiation can be detected.
- The effect never diminishes. Even after a merger, the gravitational effect has not decreased.

This means that these black holes in DP are dark matter. Again, there are no new elementary particles or fields. The formation of dark matter is a necessary part of the process.

6.5.3.4 Black holes at the beginning of spacetime

Due to their tiny cross-section, these black holes would not merge even in the early universe. However, black holes will behave like elementary particles and gain mass during the inflation phase. These objects are stable and will gain ever greater mass as spacetime density "thins out". The black holes must first form and can then grow. Therefore, not all black holes will undergo a large increase in mass. This means that we will probably have black holes in the universe even before the first molecules. And then there will also be some with greater mass. It should therefore come as no surprise if a JWST finds more and larger black holes than the standard model of cosmology or the growth limit of general relativity (Eddington limit) allows. We don't have to wait for star formation and collapse.

This means we have found our estimation error in the mass of black holes. They do not have to derive their mass solely from the accumulation of matter. Black holes also grow with the expansion of spacetime. Very strongly until the kink in the diagram, then less and less. In addition, gravity increases at the black hole and creates resistance to expansion. The calculation for this is therefore not simply linear. It is somewhat more complicated.

Based on the DP, the JWST must find many large black holes in the early universe that cannot be explained by standard models.

6.5.4 The kink in the diagram

As can be seen in the diagram, inflation does not stop abruptly but weakens with a "kink." Not linearly slowly. However, this has the effect that the elementary particles have a smaller momentum at this time than is assumed in the standard model. The dilution of spacetime to the spacetime density of a particle can also be seen in the momentum. However, momentum is the "antagonist" of gravity. The statement that momentum from an interaction in an early universe is no longer as valuable follows in exactly the same direction. Gravity can capture elementary particles more easily. Individual objects, such as stars, may be larger than predicted during this phase. Once an object has generated a large gravitational effect, the effect weakens as gravity again exerts greater resistance to expansion. Unfortunately, this again leads to the conclusion that it is not possible to simply calculate this back linearly. It is much more complicated than that.

6.5.4 The long straight line

The long straight line after the kink is the most boring part of the development. Don't forget to read the diagram from right to left. Everything here proceeds as described in the textbook. The last 13 billion years or so of spacetime lie almost entirely on this straight line. Inflation and the kink have an enormous impact but are the smallest part in terms of time. From the straight line onwards, the expansion rate can be considered almost constant.

Based on this progression, the expansion should continue to decrease from the past toward the future. Observations show the opposite. The culprit is easy to find. If it is not spacetime itself, then it is QM. In textbook physics, attempts are made to identify the vacuum through quantum fluctuations as the driver of expansion. In our case, QM does exactly the opposite. It prevents spacetime density from expanding. In our case, the vacuum is also a spacetime density and therefore has energy. This must also be reflected in QM. This results in quantum fluctuations in the vacuum. No negative energy needs to be borrowed for pair formation. Spacetime corresponds to energy. This means that energy is always present.

This means that we have several factors responsible for expansion. Expansion should simply slow down due to the behavior of spacetime itself. As the universe clumps together due to gravity, expansion encounters ever greater resistance. So, expansion must decrease after all. However, the energy density and thus the "braking power" of the QM is also decreasing. Here, too, we cannot simply calculate expansion linearly. Unfortunately, that is too simplistic. The universe should have a different Hubble constant in the different phases of its development.

What we do not have is dark energy. This is not needed in DP. Spacetime itself is the driver of expansion. This is why the cosmological constant Λ in Einstein's field equation makes sense. It is simply a scalar value for the metric. This value must be greater than zero; we are expanding. However, this value is not constant. It corresponds to the curve in the diagram and must become smaller and smaller. We will come back to this in a moment. However, due to the many factors involved, the expansion does not proceed as evenly as shown in this diagram.

6.6 Measuring expansion

The expansion is mainly measured via the redshift of photons. According to our logic, this should not be possible. QM prevents an expansion of spacetime density. I have described QM as a spoilsport. I have also already mentioned that there is one exception. The exception is the photon. If this exception did not exist, we would not be able to observe an expanding universe.

The photon has no rest mass and therefore cannot explicitly have a QM representation as a black hole. A photon is an extrinsic manifestation of a 2D spacetime in 3D. In 2D itself, there is no manifestation. If we remain in the wave picture of the photon, then the wavelength is given in 3D and not in 2D. This results in higher spacetime density in 3D and cannot be captured by QM.

Therefore, redshift, as an increase in wavelength, is directly the spacetime expansion. This redshift is not an effect of objects moving apart. It is 1 to 1 expansion. This also makes sense, since a photon that was created 13 billion years ago could not have known about the existence of Earth or a telescope. This cannot be purely relativistic due to observers.

6.7 Cosmological constant

We urgently need to address the mathematics of GR here. Until now, we have used the field equation in this form:

$$\boldsymbol{G_{\mu\nu} = k * T_{\mu\nu}}$$

The Einstein tensor indicates the curvature of space, and the stress-energy tensor indicates the source. The stress-energy tensor is the collection of all different mass-energy equivalents. However, part of the collection of mass-energy equivalents is missing. More precisely, the largest part of the energy in the universe. Spacetime itself, the vacuum. In a vacuum, the stress-energy tensor is zero. However, this does not correspond to our understanding. Every point in spacetime has an energy greater than zero. This means that we have to incorporate an evenly distributed quantity into the equation for the vacuum. Mathematically, the simplest solution is a constant for the metric. In fact, this is one of the few changes to the field equation that does not destroy the structure behind it.

We must use the field equation with the cosmological constant. The formula then looks like this:

$$\boldsymbol{G_{\mu\nu} = k * T_{\mu\nu} - \Lambda g_{\mu\nu}}$$

I write the cosmological constant on the side of the stress-energy tensor, as this is an energy contribution. The cosmological constant is simply a scaling factor on the spacetime metric. This fits with our explanation. Spacetime undergoes length and time relaxation to the same extent. This is simply a constant number. However, the number Λ is not constant. It must follow the curve from the diagram above. The sign must be different from the stress-energy tensor. This part of the energy produces a "negative" energy contribution. A larger spacetime density is a plus and a smaller one is a minus. Therefore, we need a positive constant. A Λ smaller than zero would counteract our logic. In the QM representation in 2D, we therefore need an anti-de-Sitter spacetime. This must counteract the cosmological constant. In fact, according to GR, a black hole in 2D is only possible in static anti-de-Sitter spacetime.

6.8 Comparison with textbook physics

There are many more aspects to cosmology than those listed in this chapter. However, we have to draw the line somewhere. As the final part on cosmology and also part 2, we want to compare the views of DP and textbook physics.

Here, we will only discuss a comparison of the view from the Friedman equations to DP. Anything else would result in a very long text. We will see that there are actually only very minor differences. We need to get to the bottom of the question and assumption behind the Friedman equation. Then we get something similar to SR. Although the spacetime density does not appear to be compatible with SR, we get the same results.

6.8.1 Homogeneous and isotropic = spacetime density

The first step toward the Friedmann equations is the assumption that the universe is homogeneous and isotropic. Observations of our immediate surroundings, e.g., our home galaxy, suggest the opposite. Hence the assumption that this is valid for large scales in the universe. This assumption does not hold true. There is no clumping in the universe. According to the stress-energy tensor, the mass distribution in the Friedmann equation is completely homogeneous, without any graininess. This brings us to two points.

- The universe corresponds to spacetime density. This is always homogeneous and isotropic for us. The initial conditions of the Big Bang in DP and textbook physics are identical.
- The stress-energy tensor has the signature $(-c^2\rho, p, p, p)$. All other values are zero.

These two points have several implications.

Homogeneous and isotropic are entered into the signature as 100% homogeneous and isotropic. This means that there are no distinguishable mass-energy equivalents in this approach. The universe is regarded as a single large mass-energy equivalent. No "granularity," no matter how fine or course, is intended. Thus, the mass density $c^2\rho$ in the 00 element of the stress-energy tensor is a true continuum. This is a very good description of energy density. Full agreement.

Since the energy density in the 00 element cannot fluctuate, there can be no gravity from the DP perspective. In textbook physics, the reaction to energy density is also considered to be gravity. But then a repulsive one. We do not classify this as gravity, but as expansion. The deformations of the spacetime components are different. Except for the naming, however, there is also agreement.

6.8.2 Where does the pressure come from?

The big sticking point is the pressure p on the 11, 22, and 33 elements. Here's a simple question about this. Where does this pressure come from? The textbook has a simple answer: thermodynamics. There are particles in the universe that interact, and this creates pressure. In principle, it is assumed that the energy density of mass distribution corresponds to that of dust.

The individual particles then participate in thermodynamics. The mass distribution behaves like a liquid. There is always pressure within it. The entire assumption for the pressure is based on the fact that mass is present in point-like particles. We don't know it any other way. These particles have momentum and thus generate pressure. Pressure on what? Does mass with momentum generate pressure on spacetime? Then we are back to the discussion of coupling to spacetime. If we assume individual particles, then this would also have to be included in the energy density. But this is a pure continuum. The pressure does not match the energy distribution.

This means that two assumptions are included in the stress-energy tensor: a homogeneous and isotropic distribution of energy density and pressure exerted by the particles on themselves. The granularity for the pressure is not included in the energy density. The pressure is exerted on the 11, 22, and 33 elements. This is not pressure like momentum in a specific direction. I would consider this a self-fulfilling prophecy. We put in "scalar" pressure and get "scalar" response from spacetime.

In DP, this pressure results from length and time relaxation. This is a "negative" energy for energy distribution. The signs of energy density and pressure must be different. According to the deformations of the spacetime components, these are the counterparts of each other. The cosmological constant is the behavior of the metric. The pressure is the appropriate energy specification for this.

We can therefore conclude that DP enables the assumptions of the Friedman equations better and more easily than textbook physics can.

6.8.3 Scale factor for space or spacetime

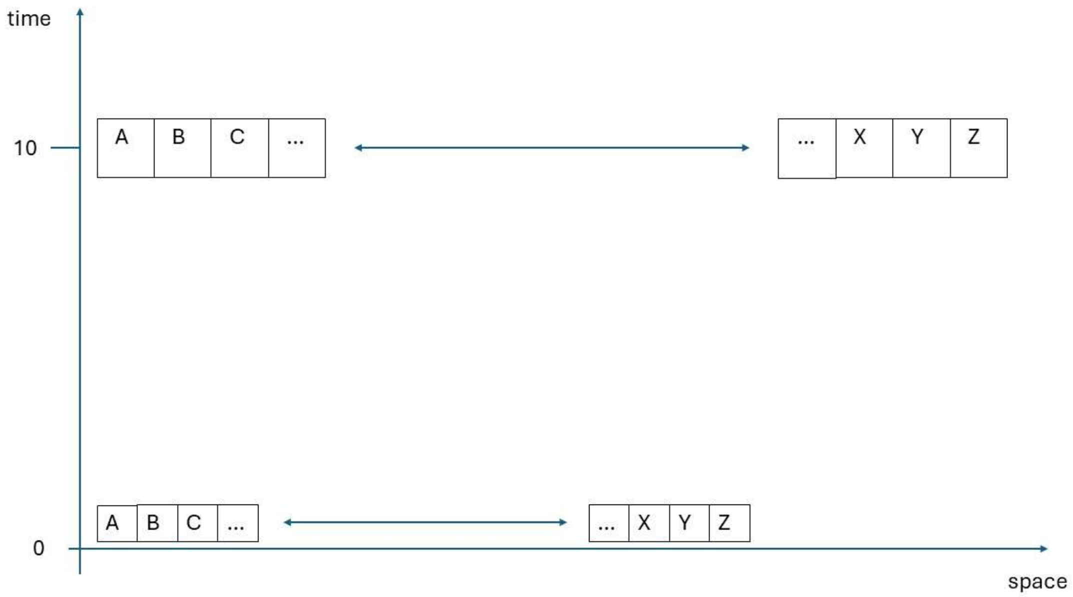
There is another major difference to discuss here. The Friedman equations give us a scale factor for space, not for spacetime. In the DP, however, we always assume a change in spacetime. Space as an independent object no longer exists there. What is the difference here? The simple answer is that there is no difference.

In the Friedman equation, the time component also changes. This can best be seen when the stress-energy tensor with the signature is inserted into the equation. For the 00 or, better, tt component of the stress-energy tensor, we obtain a term in the Einstein tensor. It looks like this:

$$\frac{\dot{R}^2}{R^2} + \frac{k}{R^2} = \frac{8\pi G}{3}\rho$$

The time component has an active effect. The problem with this is that we cannot recognize the effect on time in the given question and assumption of a homogeneous and isotropic universe. Consider the following image:

Figure4: Shows the temporal development of length and time relaxation



We are at point A and measure the distance to point Z. The rest of the alphabet is represented as points along the route. At time t = 0, we have a fixed distance R between A and Z. We take another measurement at t = 10. As a function R(10), since the distance must depend on time.

Each letter on the distance has now become x larger. This applies equally to every letter, as we are assuming a continuum. If we now want to determine the distance, the change over the distance is added up. The further away the letter is, the greater the distance has become. We see this in the expansion of the universe.

Due to the continuum, time also speeds up for each letter on the line. Time relaxation is a faster passage of time. This means that the passage of time is identical in each letter. There is no difference in the passage of time from one letter to the next. The crucial thing, however, is that we want to query the new distance at R(10) at point A. The change has already been incorporated into the time parameter 10. These are no longer the identical 10 seconds as at t = 0. However, we cannot determine this. The definition of time has changed. 10 time units are 10 time units for every letter on the route.

The route change adds up in time. The time change is already included in the question and is not added. Of course, spacetime is always adjusted in the Friedmann equation. But we cannot determine this. The assumptions and the question specify that there must be no time relaxation from this equation. Otherwise, we would be counting the time relaxation twice. The funny thing is that we would otherwise refute a basic assumption of SR, namely that there is no simultaneity.

6.8.4 Timescape model

For the DP, the Timescape model represents a very good test of cosmology. This model does not assume a homogeneous universe. Since there are areas with high gravity, e.g., galaxy clusters, and areas with weaker gravity, e.g., voids, different perspectives are created for the escape velocity of objects. This means that dark energy is not needed here. The difference here comes only from the difference in gravity and thus from time dilation. However, the effect may be too weak to explain the ever-increasing expansion.

According to DP, this effect must be greater. The reason is that spacetime is expanding in our universe. This further amplifies the difference in time dilation. What I believe is not taken into account enough is that we make measurements of supernovae, always from our high gravitational potential (from a galaxy) to another massive object (a large star, presumably also in a galaxy). Over a long distance (billions of light years), this does not correspond to reality at all.

We agree with the Timescape model and claim that the effects must be stronger.

6.9 Conclusion Part 2

That was a lot of work to get this far. The basic idea behind DP and how it can be applied in physics should now be clear. Certainly not all questions about DP or its interaction with SRT and ART have been answered. If you still have questions, please use the contact form on the Dimensional Physics page.

However, we still have a long way to go: Part 3, QM. The first version of this part is currently available for 2026. I am continuing to work on it. Since QM is quite a bit more complicated than GR, it will take some time. I do not want to provide the QM from an old version, as some things have changed and are no longer correct in the old version. Enter the text "Subscription" in the contact form. You will then receive an email when I have finished a new part. This will probably happen in another 3 updates.

7 Structure and content of Part 3 QM

We already learned a few things about DP in Part 2. Unfortunately, this is not enough to cover the entire field of physics. Part 1 was a brief introduction, and Part 2 actually only covers SR and GR. Nevertheless, we have already heard quite a bit about QM with the dimensional transition. This is unavoidable here. In textbook physics, GR and QM tend to be viewed as hostile to each other. This is one of the fundamental reasons why DP was developed. In DP, the boundaries are fluid. A 100% clear distinction is not possible. In Chapter 6 on cosmology, it hopefully became clear that we cannot understand, for example, the evolution of the universe without QM. In DP, QM is built on the structure of spacetime.

The depth of QM was still missing. We want to make up for that now. We will continue to try to keep the level of mathematics low. In some places, this will be more difficult than for GR. We will try anyway. In our explanations, we will very often use good old quantum mechanics (QM) rather than quantum field theory (QFT). The low-dimensional spacetime configurations correspond to the fields of QFT. Therefore, this mathematical modeling is almost exact for the approach from DP. Mathematics for QFT is too difficult for a broad audience. Many things are easier to explain in QM and mathematics is less complex.

We will start this chapter with a brief review of topics from Part 2 that are important for QM and that we should always keep in mind as we continue reading. The last section of this chapter covers the structure and content of Part 3.

7.1 Brief review

Here we want to recall the points important for QM that were already discussed in Part 2. These points are all related to the low-dimensional transition from 3D to 2D. As is usual in QM theory, these are almost exclusively prohibitions:

- No time crosses the dimensional boundary. Each spacetime configuration has its own time dimension. This is why time is treated like the fifth wheel on a wagon in the formalism of QM.
- No direct geometric information, such as length, size, distance, etc., crosses the dimensional boundary. As with time, this means that location is “degraded” to a simple parameter in QFT.
- Every n-dimensional spacetime volume contains an infinite number of (n-1)-dimensional spacetimes. We have a direct mapping to n-1 and no deeper. It follows that, for example, a neutrino (which we have located at 1D) cannot be generated without an additional fermion or boson.
- Every n-dimensional spacetime density must be mapped to all possible (n-1)-dimensional spacetime densities. This property will lead to the famous interference patterns in the double-slit experiment. In more mathematical terms: this generates the interfering probabilities.
- What we must always remember: spacetime density is energy, the definition of spacetime geometry, and a state of motion. With the dimensional boundary, energy becomes rest mass, geometry becomes charges and interactions, and the state of motion becomes spin and chirality.

As complicated as QM may be in mathematics, these 5 points are sufficient to derive everything. Four points come from the dimensional boundary, and the last point determines that this boundary must exist.

7.2 Important new ideas for the text

We take three points from the repetition and look at what explicit effect they have in QM.

- No time during the transition. This means that no energy or space-time density can be transferred directly.
- No geometry during the transition. This means that, from a 3D perspective, we cannot specify a distance in 2D, for example.
- An infinite number of low-dimensional spacetimes. This gives us an infinite number of possibilities and combinations for a low-dimensional manifestation.

If we write down the essence of these points as keywords, we get:

- Instantaneous reaction (no time)
- Non-local properties (no distance)
- Only probabilities (infinite possibilities) and superposition (combinations of possibilities)

In these 3 points, we have almost described all the "strange" or at least non-intuitive properties of QM. The dimensional transition is responsible for almost all properties of QM. But only almost, e.g., Heisenberg's uncertainty principle is already included in the definition of spacetime density.

Then we will learn about new spacetime configurations. So far, when we have talked about 3D spacetime, we have only had the possible mappings to 1D and 2D. That is a little too little for the entire particle zoo of the Standard Model. We will combine 1D and 2D spacetimes into new spacetimes. This will then result in fields for all elementary particles, fermions, and bosons. In particular, strange things will happen, such as 3D ≠ 3D. If we build a new spacetime configuration from three orthogonal 2D spacetimes via at least one black hole, it will contain all three spatial dimensions, but it will not have a 3D spacetime volume. This explicitly does not correspond to our spacetime. The volume will still be zero. This will necessarily result in the three families or generations of fermions.

Another point to which we assign a different meaning here is information. In DP, information will always be bound to a spacetime configuration. This has enormous implications for the process of measurement. We will recognize that the "collapse of the wave function" is not bound to the measurement, but to the generation of information in 3D. As is customary, we will discuss the double slit. In order to understand the result of the experiment, the concept of information must be better defined. Then it is no longer a problem that an interference pattern only occurs when the path information at the double slit is not available. Even if the information is subsequently deleted. In DP, there is no causality backward in time. The information is either there, or it is not. A point in time or a time sequence plays no role across the dimensional boundary.

We will stop the list here. What we can recognize, however, is that we are continuing exactly where we left off. Well-known terms, such as information, must be questioned again from the ground up. The well-known mathematics of QFT (but here almost always QM) will take on physical significance. However, this will be based on the new fundamental elements from DP. This means that Part 3 must also be read in the given order. Otherwise, we will use a familiar term such as information, and you will not have noticed the "new meaning."

7.3 Structure and content

In order to understand QM within DP, we will first clarify some basic concepts of QM. These are the first five chapters: superposition, uncertainty, entanglement, probability, and quantization. This is a very subjective selection on my part. Some claim that everything can be derived from a single point, such as superposition. I believe that after the five chapters, we will have a simple and understandable structure of QM. There are sayings such as: “Anyone who thinks they understand QM has not understood it.” We want to prove that QM can also be understood logically. We cannot use these points as a kind of axiom for QM. We only have GR with spacetime density and dimensional transition. No new elements are added here. Therefore, it is important for us to already understand the basic concept of QM from these points. The rest is then just a deepening of the ideas or the appropriate mathematical description.

After that, we will have to look at the mathematics. Don't panic, it will remain understandable. We will clarify questions such as:

- Why is it necessary to calculate with complex numbers? The result of the calculation never contains complex numbers.
- Why can we calculate with path integrals?
- Why is the Schrödinger equation all about energy states?
- Why is the Schrödinger equation called the “wave equation”? The equation does not have the structure for this at all.

Then we will take a closer look at the measurement with the double-slit experiment. We will see that there is nothing inexplicable, such as a collapse of the wave function or anything similar. The concepts discussed earlier can be clearly demonstrated here. In particular, the outcome of the experiment can only be understood logically if the DP's view of the concept of information is known.

Before we can look at the particle zoo, we need to look at the topic of fields. For us, these are the spacetime configurations. Only when we have a description of these can we understand the structure of elementary particles. That is why the Standard Model comes right after fields. The interactions between particles are described in the last chapter. The Standard Model with interactions will take up two more large chapters, but then we will be done. I hope you continue to enjoy reading DP and gain new insights.

8 Superposition

We will start with superposition. We will do this first because in many lectures, superposition is described as the most fundamental property of QM. The solution theorem for superposition will be used almost the same way for entanglement and probabilities. Even the big point of contention—local and non-local—can be easily explained with it. Therefore, we will describe the idea of mapping superposition in more detail.

Before we explain superposition via the DP, however, we should first discuss what is meant by superposition.

8.1 Explanation of superposition

Mathematics is helpful for explaining superposition. Here, mathematics is easier to understand than logical explanations. We have a linear differential equation f(x), regardless of what it is supposed to be. This mapping has a solution L. Now it may be that R is also a solution of f(x). There may be several solutions. Then, according to a mathematical theorem, L+R is also a solution to the mapping. This always works for linear differential equations in QM. Important! The additional solution is not L or R, but L+R. The combination of the solutions is also a new solution. This does not only work with two different solutions. In QM, we often need an infinite number of solutions. This sounds very simple mathematically, and it is.

The entire QM is represented by linear differential equations. That's a good thing. QM is very complicated. It is only because it is a linear representation that we can calculate anything at all. However, this also means that if QM is the correct mathematical representation, and we assume that it is because it has been confirmed so well, then this behavior must also occur physically. In the case of a somewhat abstract description, such as the spin of a particle, we have no problem with such a statement. Then an electron simply has a combination of spin up and spin down at the same time. That doesn't keep us awake at night. The situation is different with states that are familiar to us. This is where Schrödinger comes in with his cat. According to QM, Schrödinger's cat is both dead and alive until it is measured. That doesn't sound so understandable to us anymore.

In my view, however, the location of a particle is the best explanation for superposition. For us, a particle can exist at exactly one point in spacetime. According to QM, this is not correct. The clearly defined location only occurs during a measurement. Before that, a particle can be in many places at once. Every location is possible. Perhaps with a very small probability, but the possibility exists. This means that when we send out a particle, e.g., an electron, directly away from us, it is only highly probable that it is traveling away from us in a straight line. However, it could also be to the left or right of the straight line, albeit with a lower probability. This does not mean that the particle has a definite location, and we simply do not know it until we measure it. The particle is present in all possible locations at the same time. We are not familiar with this from our everyday lives. Okay, we sometimes think we have put a key in exactly this place, for example, and it is not there. But that has nothing to do with quantum mechanics. In our everyday world and also in GR, an object is present in exactly one position. In QM, the particle has the position left L, center M, right R, and additionally together (L + M + R). Location is where we have the worst case scenario. If we do not choose a specific setup for an experiment, then a particle has the entire spacetime available as a possible location. The electron is simultaneously present throughout the entire universe. Based on this mathematical approach, superposition is difficult to understand purely logically.

8.2 Problems with superposition

With SR, there may be disagreement about the timing, distance, and energy, as these depend on the state of motion. But in SR and GR, an object is clearly located in one place. Without this property, we cannot make any statements about an object in GR. Where should gravity/spacetime curvature be aligned if the energy/spacetime density does not have a clear location? This is the fundamental problem with unifying GR and QFT. In QM, the superposition of all properties of an object is the basic structure of the description. This means that an object or an interaction is not local. This means that the properties and interactions do not have a unique position. In GR, all objects are local. They must have a unique position. Otherwise, gravity could not align itself, or momentum would have no clear direction.

The next problem is that QFT or QM do not explain superposition. The mathematical descriptions were chosen to correspond to the experimental findings. This is the usual procedure. This also happened with gravity. Einstein had the idea of geometric mapping in spacetime. The field equations were constructed to correspond to the physics known at the time. For example, a major change was made for energy conservation. The mathematical description then gave rise to predictions such as black holes, gravitational waves, etc., all of which have been confirmed without restriction. It was no different in QM. In order to explain the double slit and the hydrogen atom, QM had to be constructed as a linear description with superposition and probability. All other statements of QM, such as the uncertainty principle, were found purely through mathematical description and subsequently proved to be correct. No matter how crazy the statements may sound to our everyday world.

8.3 Philosophical interpretations of QM

In GR and QM, it is not possible to specify why we must choose this representation. In GR, Einstein's idea of a geometric representation in spacetime is still reasonably "suitable for everyday use." Therefore, there are fewer philosophical points of contention to discuss here. The main topic is almost always how to understand spacetime itself. In 2026, the discussion of whether spacetime is fundamental or emergent is a hot topic.

This is much more difficult in QM, as the number of topics is much greater. This is because QM has undergone an almost purely mathematical development. There is no comprehensible general basic concept, such as a geometric representation in spacetime. From a philosophical point of view, everything in QM is therefore "questionable." There is no clear logical basis. This leads to an almost unmanageable number of "interpretations" of QM. Let's take the Copenhagen interpretation of QM as an example. This is already a collection of different interpretations. Here, it is taken so far that a particle between two points cannot be assigned a distance/path. Even the existence of the particle is not recognized until a measurement is made.

We want to resolve this dilemma. We will provide justification for everything in QM. First of all, we must reject the Copenhagen interpretation. In fact, the description of QFT with path integrals is a suitable mathematical representation based on the DP. The different paths exist and are also traversed. Just not in our spacetime.

8.4 Superposition with the DP

Let's look for a possible mapping of superposition in the DP. As always, we don't have many options. For almost all topics in QM, it will boil down to a mapping in a low-dimensional spacetime. The crux of the matter is the interface between 3D and 2D. We always obtain two fundamentally different representations for a spacetime density. One in 3D, according to GR, and at the same time an infinite number of representations in 2D, according to QM. This means that we do not resolve the two incompatible representations of GR and QM into a single representation. This "single" representation is the actual desire in a unification of GR and QFT.

We must retain these two representations and connect them across the low-dimensional boundary. This is how it will work.

8.4.1 Spacetime density in 3D and in 2D

To begin with, we have the same problem as GR with QM. Spacetime density in our spacetime has a unique position. This has to be the case, otherwise GR no longer works. This means that the electron in front of us, which we want to accelerate away from us in a straight line, does exactly what we would classically expect from a particle according to Newton. It is not to the left or right, but in the middle with a straight momentum towards the target. At first glance, this has nothing to do with QM. This is also only one side of the coin. The part from the perspective of our 3D spacetime.

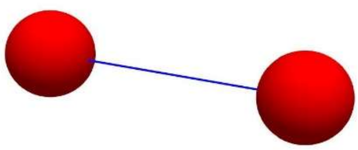
We come to quantum mechanics because every 3D spacetime volume and spac-time density is nothing else, always has an infinite number of 2D spacetimes available for mapping. Spacetime density therefore always has two simultaneously valid descriptions:

- The definition of the geometry of n-dimensional spacetime. In our 3D spacetime, this is the GR.
- The definitions of geometry in an infinite number of (n-1)-dimensional spacetimes connected to the volume of n-dimensional spacetime, which is quantum mechanics.
- **Exception:** If the spacetime density for the n-dimensional spacetime is too large, it transitions into a black hole and thus into an (n+1)-dimensional spacetime. Then this spacetime density cannot be mapped in an (n-1)-dimensional spacetime. A spacetime density cannot lie simultaneously in the higher-dimensional and lower-dimensional interfaces. The spacetime density is already too high for our spacetime, so it cannot be mapped onto a lower-dimensional spacetime.

With the infinite number of lower-dimensional spacetimes, we can place at least one straight line from any point in our spacetime into the spacetime density of the electron. Based on this idea alone, it is possible to reach any spacetime point in 3D via 2D. A spacetime density from 3D can thus reach a spacetime point even away from its 3D path. However, this is only possible via 2D.

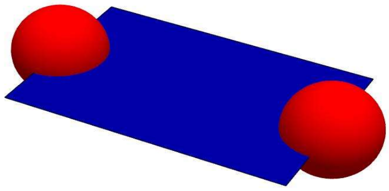
Important: We have an infinite number of paths via 2D, from a spacetime density with its local volume in 3D, to every possible spacetime point in 3D spacetime. These paths all exist simultaneously in 3D. This means that they must influence each other in 3D. How exactly this happens is explained in the later chapters on mathematics and then represents the interference of possibilities. The 3D spacetime density still has a say in the matter.

Figure1: Electrons connected by a line



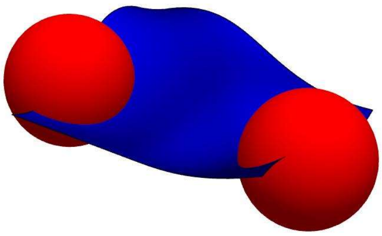
The straight line as a connection does not yet fit. Our spacetime is 3D, so the connection must be a 2D surface. We only ever go one spatial dimension deeper.

Figure2: Electrons connected to a plane



This is just one possible connection. If we rotate the surface between the two volumes around the connecting line, we can place an infinite number of 2D spacetimes between this distance. This alone allows us to reach all spacetime points in our spacetime. But that is still not enough. Who says that the 2D spacetime between the volumes has to be straight? There are many more ways to reach the points via an extrinsically curved 2D spacetime.

Figure3: Electrons connected by a wavy plane



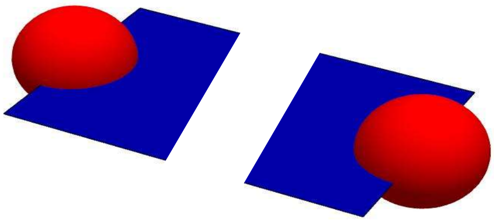
8.4.2 Connection via spacetimes

However, there is one important limitation. We only have one "type" of object available for a connection: spacetimes. All fields of QFT, and thus also the possible paths, are constructed by us using spacetimes. In DP, we have no other object available. In order for spacetime to be described by GR, spacetime must have certain properties. The two fundamental properties are: continuity and differentiability. For GR, we also need a certain "type" of differentiability, but this is not relevant here. These two conditions are mandatory in any n-dimensional spacetime.

8.4.2.1 Continuity

We need continuity because otherwise we would obtain different spacetime boundaries. Spacetime must not have any "gaps." Neither in 3D nor in 2D, otherwise there may be no connection.

Figure4: Electrons with a plane with a gap without a connection



This is **not** how it should look.

In every spacetime, the image of a spacetime density always has a connection to every other point in spacetime. To repeat:

- Spacetime itself is a spacetime density.
- Spacetime is continuous

This means that the electron already has a connection to every possible spacetime volume in 3D. There are no boundaries within spacetime. Only the bridging of the distance deviating from the momentum is not possible directly in 3D. We do not need a description of QM for the straight path.

Through 2D spacetime, the electron has additionally gained an infinite number of paths to any given point in spacetime. However, only those paths that are continuous and thus uninterrupted may be counted. In fact, we will see later in the double-slit experiment that we cannot explain this experiment if we assume that an electron can "jump" directly from the source to the target (detector screen) without a path. Then it would not matter whether it is a double slit or not. Real "beaming," as in Star Trek, from source to target is also not possible here. Paths must exist. However, the rule is that if I have at least one path in 3D, there are always infinitely many in 2D.

8.4.2.2 Differentiability

Differentiability is a simple mathematical term. It can best be translated as "round and connected geometry without corners and edges." Here, a picture really is worth a thousand words.

Figure5: Is clearly differentiable

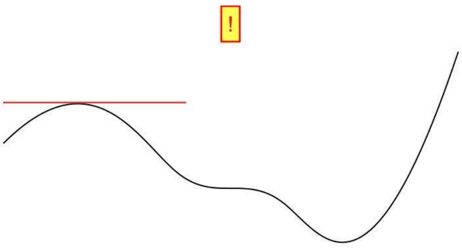


Figure7: An edge is not clearly differentiable

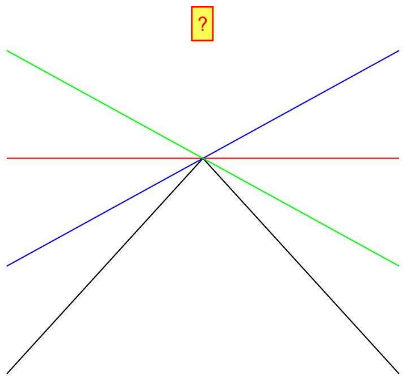
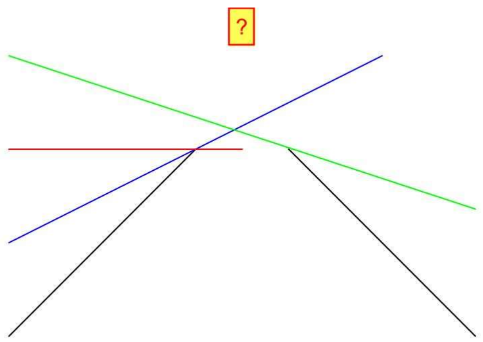


Figure6: A gap is not uniquely differentiable



If you approach a specific point of a function from the left and from the right, you must be able to draw a unique tangent there. With a "smooth" function, this is always possible. With a function that has a corner or edge, this is not possible. There, you could draw an infinite number of tangents. This point is precisely where differentiation is not possible. Our argument of continuity also plays a role here. If there is a jump, we cannot draw a unique tangent at the jump. So much for simple mathematics.

Why is this differentiability so important to us? As a reminder, spacetime density is energy, geometry, and state of motion. Spacetime density is directly mapped in the geometry of spacetime. This also applies to the state of motion. The geometric mapping of a state of motion is differentiability.

No differentiability => no state of motion => no spacetime density => no spacetime. Spacetime density is spacetime itself. With non-differentiable spacetime, our approach would be useless.

This property is important again for mathematical representation. It influences the structure of the Schrödinger equation. In 3D, there are changes in spacetime, so we need to be able to differentiate twice. In 2D, everything is static. A simple differentiation is sufficient there. Since we can only allow "round" mappings, a wave description will explicitly be useful. Flat spacetime is the special case. But more on that in the chapter on mathematics.

8.4.3 Bridging the connection in different spacetimes

A crucial question is: How do we bridge the distance in 2D? The answer is somewhat different than we would assume in the first step. In 3D, i.e., spacetime with spacetime density, the answer is momentum (directed spacetime density). Even if a certain amount of time is required to bridge the distance in a 2D or 1D spacetime, no time passes across the interface. Therefore, the process can take as long as it wants. In our 3D spacetime, every low-dimensional process will always happen instantaneously. We only know time in our spacetime. However, we have to use 2D spacetime specifically for QM. There, all images are static. We already had this in cosmology. How can an image, e.g., as a black hole, bridge the distance in 2D if there can be no change in spacetime?

Anyone who wants to invest 2–3 minutes here and come up with the solution themselves has understood the basic idea of DP.

The black hole or the extrinsic spacetime curvature in 2D does not have to bridge the distance at all. Again, every n-dimensional spacetime density is the n-dimensional spacetime itself. If 2D spacetime connects the destination and source in 3D, then everything needed for bridging is already present with a spacetime density. Spacetime and thus a spacetime density in 2D connects the locations in 3D simply by its existence. Whether the 2D spacetime itself has an extrinsic deformation or an intrinsic deformation as a black hole is irrelevant for the connection. With these deformations, the connection/spacetime only maps the properties of the particles. However, the existence of the particles is spacetime itself. It does not matter where these properties lie on the "path." We cannot recognize any geometric quantities such as distance/length, etc. from low-dimensional.

Only two properties are important.

- The path in 3D is bridged by the existence of a continuous and differentiable 2D spacetime
- The 2D spacetime has an extrinsic deformation or a black hole, otherwise we cannot perceive it in 3D

This means that flat 2D spacetime drawn in the first images cannot be recognized in 3D without a black hole. More on this later in the standard model.

However, from this bridging of a distance in 2D, we can make a demand on QM. All recognizable interactions from 2D to 3D must always and without exception occur instantaneously. If an interaction has a delay, this part always originates from our spacetime. We will revisit this in the context of entanglement.

8.5 Energy across the dimensional boundary

If we obtain an infinite number of images as spacetime density in 2D from a single spacetime density in 3D, do we not then have a miraculous increase in energy? No, fortunately not. In DP, energy conservation remains valid. However, only separately for each spacetime.

In fact, this topic is not so easy to answer; it has many different facets. This is the description of the interface between 3D and 2D. This is exactly what the entire Part 3 is about. Therefore, we divide this into two areas. For the first area, the specification of energy, the answer can be found in this section. For all other open questions on this topic, and there are quite a few, we will explain this in the respective sections in Part 3.

Energy cannot be transferred across the dimensional boundary because time cannot be transferred. Energy can only be explained in relation to a specification of time, hence:

- $E = mc^2$
- $[E] = [\frac{kg*m^2}{s^2}]$ as units of measurement

Spacetime density = energy = spacetime geometry = state of motion. A specification without time is not a complete representation in spacetime geometry or the state of motion. Without time, there is no energy. This means that, from the perspective of 3D, no energy is transferred from 3D to 2D. In 3D, spacetime density remains exactly what it is. Spacetime density in 3D does not emit energy into 2D spacetime.

What does it look like in 2D? It depicts spacetime density and thus also energy. Yes, that's right. But the energy only exists to a limited extent in this spacetime, as an additional representation of the 3D spacetime density. The representations in 3D and 2D are based on the same energy, without 3D having to transfer energy to 2D. This means that this principle can be applied an infinite number of times. The mere existence of a 2D spacetime is a spacetime density and thus an energy. However, it does not count as energy in 3D. To do so, the 2D representation must bridge the boundary to 3D and thus enter quantization as an effect in 3D and not directly as energy. We describe this in more detail in quantization. We will take a closer look at what the individual representations look like in 2D in the standard model.

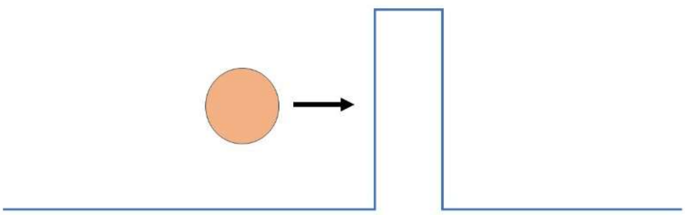
So, could we already be done with superposition? Superposition arises because we have an infinite number of 2D images at the same time. However, the word "simultaneously" should be used with caution here. In QM, just as in relativity theory, there is no longer any simultaneity. In relativity theory, this is due to the maximum speed of light. In QM, there is not even a temporal reference between the different spacetimes. This will become important later when we discuss the double-slit experiment. First of all, nothing has ever changed backwards in time. There is no forward or backward between spacetimes.

However, there is a second aspect to superposition that is important here. Superposition also exists for properties that do not relate to location. If we want to have superposition everywhere and in all properties, then the individual 2D image must also have a special geometry. To stay true to the example with location, we will describe this using an effect that only exists in QM, the tunnel effect.

8.6 Tunneling effect

The peculiarity of the geometric mapping in a single 2D spacetime is beautifully described by the tunneling effect. Let's take our electron again, which we shoot away from us in a straight line. We place an obstacle in the path of this electron. The obstacle does not need to be a structure made of rest mass, such as a thin wall. A strong electric field that a charged particle cannot pass through is also sufficient.

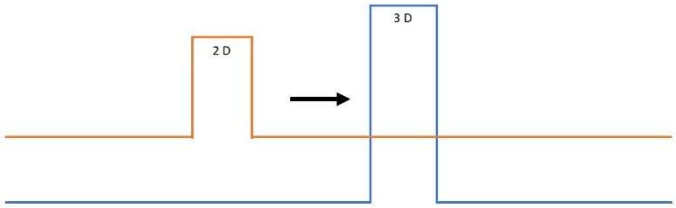
Figure8: An electron in front of the barrier



Our expectation is that the electron will not make it through the wall. This is also the description of classical physics. In QM, the electron may, albeit with only a small probability, pass through the obstacle to the other side. The reason for this should now be clear to us.

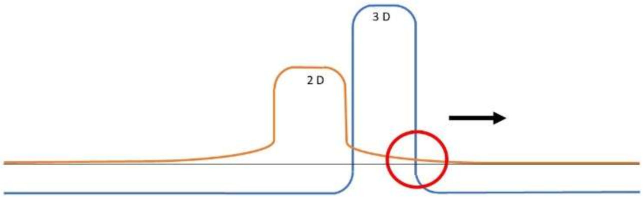
We simply map everything as geometry in continuous and differentiable spacetime. It follows that a "digital" mapping is not possible, even though we are talking about quantum mechanics. The spacetime density of the electron and the obstacle must **not** look like this.

Figure9: Digital description as spacetimes



Both objects always look the same in 3D as well as in 2D.

Figure10: Differentiable mappings in spacetimes



This wave mapping therefore always has the two properties that are most important for tunneling.

- There are no corners and therefore no breaks in the geometric mapping.
- The geometric mapping is in spacetime itself and is therefore always as large as spacetime. For us, this is infinite.

If you like, the term quantum mechanics is completely wrong from the perspective of geometric mappings. The mapping must not be quantized. We always create a possible overlap of the geometric mappings. This is the red circle, which lies behind the obstacle. We will discuss how we measure the electron there later. We will discuss interaction and measurement in a separate chapter.

However, the distance can only be bridged in 2D. In 3D, the obstacle blocks the spacetime density. This is the experimental setup. This allows us to demand that the tunnel effect must always happen instantaneously. In addition, the tunnel effect and superposition must be present for all properties of a particle. We map everything using the geometry of spacetime. This means that superposition and the tunnel effect do not only occur with momentum or location. However, we can illustrate this very clearly here. As we will see later in the chapter on the mathematics of QM, continuous and differentiable spacetime is the reason for the wave descriptions.

8.7 Summary and locality

Superposition arises because we have an infinite number of low-dimensional images that condition each other in 3D. Each individual mapping stands alone in 2D. In 3D, however, all mappings are together. Therefore, the solution is not L, M, and R individually, but also L+M+R together in 3D. Our measurement always takes place in 3D. Therefore, the behavior of a superposition may be present until the measurement. After that, it is no longer present.

The big problem of locality does not exist in DP. In every n-dimensional spacetime, the spacetime density is always local. In 2D, an infinite number of images are present in 3D at the same time. This means that no local behavior may be present in QM. Local and non-local are only the different "dimensional manifestations" of a single spacetime density. This only becomes a problem if we want to map both sides of the coin in a single spacetime. However, according to DP, this is not possible. In DP, the question of locality in a spacetime is already wrong as a question.

In fact, there is one object that already exhibits clear local behavior in 3D without 2D: the black hole. Since the spacetime density at the center of the black hole cannot have a low-dimensional image, there is no superposition here and therefore no non-local behavior. This can also be seen in Hawking radiation. If the black hole and thus the event horizon did not have a unique position in our spacetime, no Hawking radiation could form. This is because the incoming and escaping particles would statistically balance each other out if the boundary fluctuated. Hawking radiation only works if the GR part of the equation remains local and the quantum fluctuations do not. This behavior can only be explained if the black hole with its event horizon has no quantum mechanical image.

9 Uncertainty

After superposition, entanglement and probability should come next, since both can only be understood through the concept of superposition. That is correct for now. However, we will first discuss the basic elements of QM so that the concept for the entire QM can be recognized early on. The respective further derivations from these basic elements will then come later. It is a popular point of contention in QM whether superposition or uncertainty is the decisive "basic element" of QM. It is often argued that superposition (not local) causes uncertainty, or vice versa. We are pursuing a different structure here. From the perspective of DP, QM has four core elements:

1. Quantization: This was already explained in Chapter 3 (Limits of Spacetime). For a complete understanding, we need to expand on this with a few points from QM. But first, we need to discuss the new points. This makes quantization the last of our five topics.
2. Superposition: The approach to superposition is a new idea in DP and is responsible for a very large part of other phenomena in QM. Therefore, this point came first. Everything else is just refinements or derivations from this approach.
3. Uncertainty: We can discuss uncertainty separately in advance, as it is a self-contained topic without further derivation, even though it is a fundamental element of QM. In our approach, uncertainty has nothing, absolutely nothing, to do with superposition or any derivation thereof. It comes directly from the idea of spacetime density.
4. Structure of elementary particles: Once all these topics are known and have been tested in the double-slit experiment, we can turn our attention to the structure of elementary particles and interactions. There, everything revolves around the subtleties of possible low-dimensional geometries.

Therefore, we will work through the uncertainty principle. Then we will have already discussed all the basic elements of QM here. The structure of elementary particles and interactions can then be derived with a little additional idea. As always, geometry will guide us.

9.1 Explanation of uncertainty

Let's start with an explanation of uncertainty. Unlike superposition, uncertainty is not built into the underlying mathematics. It actually arises from the solution approach, e.g., via the Schrödinger equation. Uncertainty was discovered purely mathematically. As a result, the interpretation of uncertainty has changed over time. But let's take it one step at a time.

The official name is Heisenberg's uncertainty principle. It was discovered by Werner Heisenberg in 1927. It could only come after the Schrödinger equation (1926) and also had to be discovered. Unlike superposition, the uncertainty principle was not built into the basic mathematical description. It emerged later.

Heisenberg did not find the exact formulation that is commonly used today. His description was still:

$$\Delta p * \Delta x \approx h$$

To explain the formula, we will explain the official name.

The part "Heisenberg's" clearly comes from Heisenberg. The current formulation, which we will also use in the following, was found a few months later by Earle Hesse Kennard. However, this is the same principle as in Maxwell's equations of electrodynamics. He developed the basic idea, and it bears his name, even though he never saw the current formulation with four very short equations during his lifetime. Therefore, the part "Heisenberg's" fits me.

The part "relation" comes from the mathematical symbol ≈. Heisenberg did not establish an equation, but only a relation. The relationship between x and p is clear, as is the order of magnitude. However, it is not an exact equation. Hence, it is a relation. Later, it became an inequality. The somewhat less precise term "relation" is good enough here; it fits.

The part "uncertainty" is a little more difficult. We need several new sections for that.

9.1.1 Uncertainty for the first time

Let's clarify what is meant by uncertainty. The symbol Δ for p or x is not the measured value for the momentum or position. Δp refers to the deviation from the mean value of the momentum from many measurements. In mathematics, this standard deviation is denoted by the symbol σ. In fact, Kennard chose this for the exact formulation:

$$\sigma_p * \sigma_x \geq \frac{\hbar}{2}$$

For whatever reason, the misleading notation with the Δ has become established. This clarifies the term "uncertainty." This inequality always refers to the deviation from the mean value and not to the measured value itself. This inequality makes a statement about how close or far away one is from the mean value, i.e., an uncertainty.

9.1.2 Uncertainty for the second time

In the physical interpretation, they initially backed the wrong horse. Where is the uncertainty supposed to come from? This concept did not exist in classical mechanics. There, it was theoretically possible to carry out a measure with absolute precision. In QM, the end of accuracy is reached at approximately h. That is the statement of this inequality. This led to the idea that this uncertainty has something to do with the interaction during the measurement process. The symbol h stands for an effect. The relation concerns the simultaneous measurement of position and momentum. In order to measure something, we need interaction. If we want to measure the position of a particle, we do so through an interaction with, for example, a photon. However, the photon has a momentum that is transferred to the particle. This changes the value of the momentum in this measurement.

This idea persisted for a long time. Fortunately, it is now only heard of in a historical context. In today's interpretation, it is assumed that we do not need interaction for uncertainty. It is fundamentally present. It only depends on the possible combination of the measured variables.

9.1.3 Uncertainty for the third time

Uncertainty is a deviation from a mean value in a measurement. To calculate a mean value, we need at least two measured values. What does uncertainty mean for a single particle or a single measurement? The answer is clear: no statement is possible. In this derivation, uncertainty is a purely statistical statement. In a single measurement, the deviation is exactly zero and the relation is violated.

This is where it gets strange. As soon as I take many measurements, each individual measured value must adhere to the uncertainty. If I take a single measure, this is not relevant. However, many measurements consist of individual measurements. So, what now?

In fact, this is an open question of interpretation in QM. There are two interpretations:

- Statistical statement: Here, one stubbornly sticks to the mathematical interpretation. This is often a good idea within QM. There is no statement for a single measurement. The uncertainty principle only applies to many measurements and is therefore bound to a series of measurements.

- Fundamental element of QM: The uncertainty principle is given as fundamental behavior for each individual particle, even if no measurement is performed.

Later, we will get a mixture of both. If you are a supporter of the Copenhagen interpretation, then both positions are not so far apart. A particle only exists there when a measurement is taken. The only problem that remains is whether to take one or many measurements.

9.1.4 Uncertainty for the fourth time

Unfortunately, there is also a lot of "folklore" surrounding the topic of uncertainty. These are sayings that everyone is familiar with. Example: "If I determine the location more and more precisely, then the momentum becomes more and more imprecise, and vice versa. If the location is determined exactly, then the momentum is completely indeterminate." Sayings of this kind haunt some people's minds. Unfortunately, the statement in the example is wrong. Here, the facts have been simplified to such an extent that the statement becomes false. This is a mistake that I have unfortunately made more than once. Mathematics has clear advantages.

Of course, according to QM, we can measure the momentum and position of a particle simultaneously with 100% accuracy. To do this, we only need to measure the momentum in one direction and the position in another direction. The uncertainty principle only applies to momentum and position if we measure both in the same direction. Here, the uncertainty principle depends on the direction of the measurement.

But that's not all: there are measured variables where uncertainty is not relevant at all. This only happens with certain combinations. In QM, the mathematical expression of the commutator is used for this purpose. This is written out as follows:

$$[\hat{A}, \hat{E}] = \hat{A}\hat{E} - \hat{E}\hat{A}$$

With normal numbers, the result is always zero and there is no uncertainty. In QM, however, observables are meant. These are observable quantities. These are not numbers, but "self-adjoint linear operators." The result may not be zero. This happens when we set $\hat{A} = p$ and $\hat{E} = x$. In fact, it is even more complicated, because the wave function also plays a role. But we don't need to go into that much detail here.

We'd better stop here with the explanation of the uncertainty principle. We can see that there are different combinations of measured variables with different behaviors:

- No uncertainty principle
- Uncertainty principle valid without restriction
- Uncertainty principle with restriction, such as direction in our example

As always in QM, there is no physical/logical explanation for this. It is embedded in mathematics with commutators. In fact, the uncertainty principle arises from various mathematical considerations. Therefore, we can consider this to be very well established mathematically. That is not enough for us. Let's see if we can find a logical explanation.

9.2 Heisenberg and the low-dimensional limit

Let's try to apply what we have to the DP. We'll stick with the example of momentum and position. We repeat Heisenberg's formula:

$$\Delta p * \Delta x \approx h$$

In this form, the connection is not yet clear. So, let's just write the units of measurement on the left side:

$$\Delta p[m * v] * \Delta x[l] \approx h$$

It says $[mass * speed] * [lenght] \approx h$. The magic word to solve the puzzle is Planck. Uncertainty still has to do with a measurement in our spacetime. Let's insert the characteristic Planck values for our spacetime into the relation:

$$(m_P * c) * l_P \approx h$$

Then we could even turn the "$\approx$ " into a "$=$." That is our definition of h across the low-dimensional boundary.

This leads us to the following requirement: **there must be no uncertainty in gravity.** Uncertainty causes interaction. This means that it is linked to interaction across the low-dimensional boundary. The interaction causes uncertainty, not the state. With our model, we no longer have a problem with uncertainty in a 3D spacetime density with an infinite number of 2D manifestations. Gravity and uncertainty are not mutually dependent, as there is no uncertainty in a state in 3D.

This leads us to the interpretation that uncertainty only arises in the measurement process. The state is irrelevant.

Now we must not allow ourselves to be distracted by the formula for defining h. On the left-hand side, we have two separate deviations from two measured values and not one deviation from h. We check whether the Planck values make any sense here at all.

The smallest effect in our spacetime is h. This means that a deviation which, when combined, results in an effect, should make the formula look more like this:

$$(m_P * c) * l_P \geq h$$

We cannot get below h. In the exact formula, however, there is a 4π in the denominator for h. This brings us below h in the effect. This looks like an error. If we follow pure statistical interpretation, we have no problem. Purely mathematically, there may be values for a deviation from a mean value that does not exist in the individual measurement. Example: The mean number of dots on a dice is 3.5. We do not find this value on the dice. Here, the mean value is already impossible in a single measurement. The same applies to the deviation. However, we also want to have a logic for each individual measurement. Then we cannot proceed with the purely mathematical argument.

We always need a length to map a spacetime density. An effect changes the spacetime density. This means that a length must always be involved. A length cannot be measured precisely to l_P in an interaction. If we want to arrive at a Planck length in a measurement process and thus also in the deviation, we create a black hole in 3D, which in turn has no 2D representation and therefore has nothing to do with QM. In fact, we therefore have to multiply the Planck length by 2. This gives us the smallest possible deviation. We take this to the other side and then have:

$$(m_P * c) * l_P \geq \frac{1}{2}h$$

That looks better. These $\frac{1}{2}$ must therefore always occur. We are still missing 2π. We already know the problem. With the proportionality constant k in Einstein's field equation, there were still 8π. There it was 4 * 2π. Per spacetime direction 2π. Here we only have one direction and 2π are missing.

However, there is still no real reason for the uncertainty. In particular, there is no reason why it only exists to a limited extent and is not always valid. According to the argument so far, it should always be valid.

9.3 Uncertainty in spacetime density

The uncertainty can be explained very simply in logical terms. We must return to our initial approach. All forms of energy are represented as spacetime density in the geometry of spacetime. The uncertainty itself is already defined in the spacetime density.

The fundamental problem with a measurement is that we combine measured variables that measure the identical quantity in the spacetime density. Let us stick with the example of location and momentum.

If we want to measure the location in the x-direction precisely, we thereby limit the possible length in this direction. A location measurement is nothing else. However, if we also want to measure momentum, we need a lot of length. Momentum is a spacetime density relative to its surroundings. When I measure the length of the spacetime density, it has no momentum in the spacetime density itself. We only obtain this if we can compare this definition of spacetime density with the surrounding spacetime density. If we measure the location precisely, we no longer have any "surrounding" spacetime to determine the momentum. If we want to determine the momentum exactly, we need the entire length of the x-direction for the most accurate value. Then the location is undefined. Since we are measuring the identical object, one specific measurement excludes the basis for the other measurement. Therefore, we have no problem measuring location and momentum in different directions or from different objects.

Uncertainty also applies when we measure the identical object using different methods. As an example, let's take the uncertainty of time and energy. However, this uncertainty then takes on a slightly different character. This is because one measurement (time) does not affect the other measurement (energy), but rather a longer time measurement is identical to a more accurate energy measurement. Energy is the geometry of spacetime. However, this already indicates the "distance" to the spacetime boundary via length contraction. Time is exactly the same measurement. When we measure time, we measure energy.

The fact that uncertainty cannot be linked solely to quantum mechanics also comes from mathematics. We can switch between the momentum and position representations of the description. This is done using a Fourier transformation. This transformation already contains a form of uncertainty between the representations. Therefore, the uncertainty must originate from the joint observation of an identical object.

This describes the uncertainty precisely enough for our purposes. What is important for us is that the uncertainty is already inherent in the definition of spacetime density and is only connected to QM via the spacetime boundary, with the effect h. However, the uncertainty itself does not result from QM.

10 Entanglement

Let's continue with entanglement. This property is the least understood ingredient of the entire QM. Superposition and uncertainty are not discussed as much or as controversial as entanglement. In DP, we will be able to explain entanglement very easily. Without the approach from DP, it is logically impossible to find a reasonable explanation for it. Let's start again with an explanation of entanglement.

10.1 Explanation of entanglement

Like uncertainty, entanglement arose from mathematical investigations of QM. To explain the hydrogen atom or the double slit, entanglement was not necessary in the first step. Unlike superposition, it did not have to be incorporated into the mathematical model. This only became apparent later.

Entanglement has an additional important property. This only applies to more than one particle. Superposition and uncertainty already apply to us in the case of a single particle. Entanglement only really makes sense with two or more particles. From a QM perspective, it completely couples at least two particles together. Completely, because the separate particles are described by a single wave function. If you like, these particles are not separate at all in QM. This is where the problems of understanding begin.

Let's take an electron as an example again. But now let's take two electrons that are entangled. If we measure one electron as spin up, then the other electron must necessarily have spin down. This happens instantaneously and independently of the distance between the two electrons. It is important to note that one electron did not have spin up from the beginning and the other had spin down. The superposition principle also applies to entangled electrons. Each electron carries both spins until measurement. The electron that is measured first thus generates the exact spin for both electrons. As mentioned, this happens instantaneously over any distance. Don't the electrons then have to exchange information about the measurement? I was measured as spin up, so you must spin down. It is precisely this "exchange of information" that is the problem in understanding entanglement. It would then have to take place at faster-than-light speed. According to QM, with infinitely fast information transfer.

We will not go into the various points of discussion on this topic, such as Bell, ERP, hidden variables, etc. This is also a point where GR and QM do not really fit together. Although Einstein helped to launch QM, he could no longer follow the theory at this point. An effect between two particles at faster-than-light speed is contrary to every principle of SR and GR. This was referred to as spooky action at a distance.

10.2 The rescue that makes everything worse

So does entanglement show that the assumptions of SR and GR are wrong, or something else? A clear yes and no! It quickly became apparent that when entanglement is used exclusively without an additional information channel, no usable information can be transmitted. The effect on electrons with spin up and spin down is transmitted instantaneously, contrary to the assumption of GR. However, GR (as understood without DP) defines that no information can be transmitted faster than light. Since we need a second channel that adheres to the speed of light for information that is usable to us, everything is fine again according to GR. That is the prevailing doctrine.

In my opinion, this interpretation has rather prevented the actual search for a solution. The problem has not been solved. The solution was to please everyone with this interpretation without creating a conflict between the theories. In the later chapter on the double-slit experiment, this solution hits us again with full force. There is a variant with "delayed choice." It is even claimed that QM can determine something backwards in time. This is a philosophically terrible idea and 100% contrary to the assumption of DP.

10.3 Entanglement according to DP

Let's try to find a better solution. Our first approach is to look at the ways in which we can entangle particles. This is usually achieved using two methods:

- Photons: A single photon is turned into two photons with lower energy.
- Particles with rest mass, e.g., an electron: The particles are brought very close together and then cooled down to almost the absolute minimum.

In both cases, the aim is either to start from a single spacetime density or to bring separate spacetime densities very close together without interference. For entanglement, we need to superimpose spacetime densities. This brings us to the solution.

For each particle, we have a spacetime density in 3D and additional 2D images. If the 3D images are very close to each other or originate from the same spacetime density, these spacetime densities can overlap. This happens in 3D. As we saw with the tunnel effect, due to the "wave representation," the superposition can already begin when we would not yet consider them to be completely superimposed. Then there can be common images in 2D for two separate 3D spacetime densities. Not only can there be common images, but there must be common images. Each separate spacetime density in 3D occupies an intersection of the total volume in its volume. The 2D images from the 3D spacetime density must therefore be identical. We obtain exactly one superposition for separate 3D spacetime densities.

Why does the entanglement remain intact when we separate the particles spatially in 3D? As always, the dimensional interface takes care of this for us. We do not obtain any time or geometric information such as length or distance via this interface. How can a 2D image recognize for itself that there are separate representations in 3D? The clear answer: it cannot. In 2D, there is neither the distance nor the time from 3D. With this solution, we can once again make demands on entanglement:

- Entanglement must always and without exception occur instantaneously in 3D. Any time delay may only come from the measurement process in 3D. Instantaneous over any distance in our spacetime. This is identical to superposition, as it is the identical superposition for the separated particles. There is a single superposition for the separated particles until measurement.
- If we entangle atoms by cooling them, there should be no restriction on the size of this atomic cloud. We can continue to increase the superposition of the spacetime densities. Only the experimental restrictions for interference-free operation and cooling should be decisive here.
- In a superposition, entanglement is the normal case. Not obtaining entangled particles is the special case, e.g., the geometry of the 2D images does not match, or the state is destroyed by a disturbance/measurement.
- Since there is only a superposition for the separate particles, there must be no hidden or additional properties for the entanglement.
- Since the superposition is in 2D, no 3D information can be exchanged via this channel.
- Since there is a 3D connection during a measurement/interaction of the particles (information will be discussed in more detail in the double-slit experiment), the entanglement is destroyed. Then the spacetime densities are separated in 3D and each particle receives its own 2D representation.

This gives us all the experimentally confirmed properties of entanglement. Again, the discussion about whether entanglement is local or non-local is meaningless. Entanglement takes place in different spacetime configurations in which the term "local" cannot be applied.

If we look at the historical dispute between Einstein and Bohr on QM and GR, we can already see that, as so often in life, both were right. In QM, certain things happen instantaneously. In our spacetime, it is not possible to transmit information faster than light. However, both work together in separate and dimensionally different spacetimes.

Is that all there is to it? Yes, exactly, there is no more to it than that. The entanglement, which has been poorly understood until now, is a necessary consequence of our approach to superposition. When separate spacetime densities come too close to each other or are generated from a single spacetime density, we almost always obtain entanglement. The properties of entanglement are not mysterious but must exist in exactly this way.

11 Probability

It should be common knowledge by now that QM can only generate a statement about the probability of the measurement result when predicting a measurement. As with uncertainty and entanglement, this is not incorporated as a basic concept. This only became apparent later. In fact, the Schrödinger equation was interpreted differently at the beginning. It was only the so-called Born probability interpretation (rule) that provided the solution. This made it clear that even though we have all the information about Schrödinger's equation, nothing more precise than a probability can be derived from it. It is not as if further information needs to be collected in order to make an exact statement. In principle, it is not possible to obtain any information other than probability from QM.

We have already established that Einstein had his problems with entanglement. The probability interpretation was the second point. Einstein wrote to Max Born in 1926: "Quantum mechanics is very impressive. But an inner voice tells me that this is not the real Jacob. The theory provides a lot, but it hardly brings us closer to the mystery of the Old One. I am convinced that he does not play dice." With entanglement, we arrive at a common solution between QM and Einstein. With probability, however, we must side completely with QM. We will see that, based on our approach, we can only obtain a probability.

Only with a special experimental setup can we obtain a clear statement about a measurement result. If we have determined a value in a measurement and then repeat this measurement immediately afterwards, we will obtain the identical measurement result again with 100% probability. We will explain why this is the case in the double-slit experiment. The "wave collapse" during measurement is not yet an issue here. The question here is why there are only probabilities and why these have a weighting.

11.1 Basic elements for probability

For QM, we only need two basic elements for probability:

- Possibilities: We absolutely need different possibilities. We obtain these through the infinite number of images in 2D.
- Weighting of possibilities: Depending on the value to be measured, certain measurement results are more probable than others or equally probable. There must be a reason for this.

Whether the Schrödinger equation and thus probability is only a calculation or also a physical representation is a popular topic in interpretations of QM. We deviate from the Copenhagen interpretation and claim that probability clearly has a physical representation and is not just a mathematical quantity. This means that the two basic elements must have a direct representation in spacetime. However, this is different in terms of possibilities and weighting.

11.2 Possibilities

For the possibilities, we use the same basis as for superposition. In every n-dimensional spacetime volume of a spacetime density, there are infinitely many (n-1)-dimensional spacetimes and thus spacetime volumes and spacetime densities.

A single possibility cannot change itself. In cosmology, we have recognized that with only two spatial dimensions, we can only generate static images. In QM, we will later call these static images "stationary states" or "paths." In cosmology, the creation of the image was a Big Bang; in QM, this is called "creation or destruction". But then something changed in the 3D image due to an interaction. In 2D, everything remains static for the time being. When it comes to particles, these 2D images are called "virtual particles." They exist but cannot be detected in 3D because the image is in 2D.

Important: There are always an infinite number of possibilities. This is clear in the example with the location in superposition. But what about spin? We only measure spin up and spin down. There are only two possibilities. We have to be careful here. With spin, too, the direction is always completely arbitrary. If we want to measure the spin, we choose a completely freely selectable axis for this measurement. Relative to this axis, the spin has the property of up or down. However, the measurement can refer to any direction (axis). Through the question/measurement we ask the system, we divide all possibilities into up and down. However, there remains an infinite number of possibilities.

During the measurement, we will then see that the possibilities can be mutually dependent. In the case of the double slit for the particles, this will result in the interference pattern. However, only very specific locations for the individual interactions are ever displayed on the screen. This means that only one possibility is ever "drawn" during the interaction. This is where the idea of wave-particle duality comes from. We will show that this dualism does not exist. A particle is a spacetime density with a volume and not a point. But a particle is also not a wave. The distribution and mutual influence are many different individual images. These low-dimensional images cannot be assigned a unique location in 3D. We do not need to explain wave-particle duality, as it does not exist in this form. In DP, we have a duality that is a simultaneous mapping in 3D and 2D. We have neither a point nor a wave. However, when we look at the weighting, we will see that the mathematical wave description is a very good analogy for this behavior.

11.3 Weighting

There are two different types of weighting. In one type of weighting, the weighting depends on the properties of the particle, and in the other, it does not.

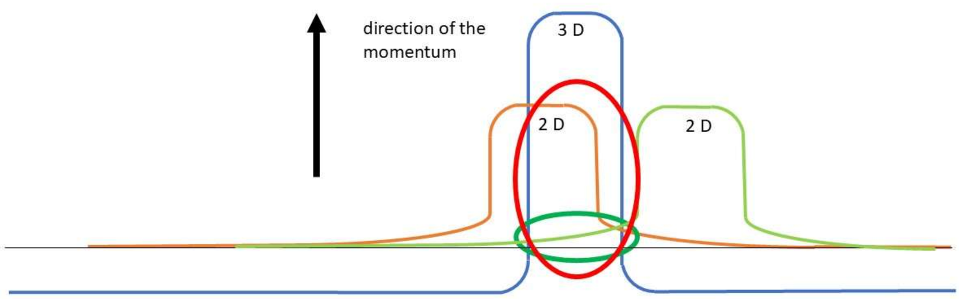
Let's start with the example of spin, as it is simpler. With spin, there is actually no weighting. The fact that we always get a 50:50 probability of spin up and spin down is due to the question. All directions are present with identical weighting. By asking about spin up and spin down on a specific axis, we divide this set into two equal portions. The result should come as no surprise. However, this also means that spin must be a characteristic that belongs to the geometric features in 2D. We cannot distinguish these from 3D and they are always the same for us. This means that there is actually no weighting. Only the weighting that we introduce through the question.

Now let's take our electron again, which we accelerate away from us. Here, things look different. The electron is very likely to follow a straight path. However, there is a small probability, which is not zero, that it will deviate from the straight path. The greater the deviation, the lower the probability. There are differences here. When I, as a human being, start moving in a straight line, I can confidently set the probability of deviation to zero. This is due to my mass, a special property of the object. At this point, I insist that this is only due to the very large ratio of my mass to that of the electron, as is the case with every other human being. Even if my wife would probably claim something different about my mass property.

Here, the weighting of probability is linked to a property, namely mass. However, mass is only one form of spacetime density. From superposition, we know that all possible 2D manifestations are separate 2D spacetimes. These must overlap spatially with the 3D spacetime density. Since all n-dimensional spacetimes are always continuous, there is an overlap at every point in our spacetime. This means that every point in spacetime would have the same weighting. Spacetime density now plays the decisive factor. We are more likely to find the electron where, in 3D, the 2D spacetime density best corresponds to the electron.

This means that, on average, the electron is most likely to be found where the 3D spacetime density is located. The images of the 3D and 2D spacetime densities overlap most strongly there. This is where wave imaging comes into play. We only have continuous spacetime. If we want to recognize something in 3D from 2D, we can do so almost exclusively via the extrinsic geometric characteristics in 2D. This makes wave mapping a good fit. The various geometric mappings in 2D can now be amplified or attenuated at certain locations in 3D. The electron will probably be most detectable at the locations where the amplification is greatest. However, we will clarify this in more detail with the double slit. On average, the probability for the electron is greatest exactly where the 3D spacetime density is located. Interference from the "waves" plays a role in the deviations.

Figure 11-1: Intersection of the representations of a pulse



The amplitude represents the direction of the impulse. The wave on the left in orange has the largest intersection with the 3D spacetime density and is therefore more likely to be measured than the wave on the right in green. The intersections in the circles represent the probability.

In the image, we can see where the overlap in the 3D spacetime density is greatest. On average, this is where the particle will be most frequently encountered via an interaction from 2D. The greater the difference in wave amplitude, the lower the probability. Since the amplitude of the spacetime density in 3D is approximately a factor of10^{32} greater for an object such as a human being than for an electron, the deviation is equivalent to zero. This is why we only perceive classical mechanics in everyday life and not quantum mechanics.

11.4 Analogy for probability

A good analogy for probabilities is an urn with balls. A damn big urn with an infinite number of balls. Well, there must be an advantage to being able to do theoretical physics.

In the case of spin, the balls in the urn are identical, with the difference being their color. Let's say white and black. Then after many removals from the urn, we will have drawn an almost identical number of white and black balls.

In the case of the electron's location, each spacetime point in 3D has a ball. The spacetime point with the greatest correspondence between the spacetime density of 3D and 2D has the largest ball. This makes it more likely to be drawn than another. However, the probability for the others is never zero. They are present in the urn. If the 2D spacetime densities influence each other, one ball becomes larger and the other smaller.

The wave image is somewhat simpler. If we reach into the urn from above, we are most likely to draw the spacetime density that has the greatest amplitude and thus reaches the highest point.

11.5 Probability for an ensemble

The argument about spacetime density helps with another case of probability. We will discuss the double-slit experiment later. This has already been done with larger objects. This is very well known for C60 buggy balls. A molecule consisting of 60 carbon atoms. Why do we not observe interference for 60 separate carbon atoms at the double slit, but rather for a C60 molecule? The probability of the location must be transferred to the entire structure and not to the components. In our example, we must move from electrons to humans.

The reason for this, as always, is spacetime density in continuous spacetime. This means that the spacetime density already overlaps in 3D, and we obtain a probability for the entire overlapping spacetime density in 3D.

We will see that this is also the reason why there can be such a thing as a "quasi-particle" in QM. You see, for QM to work, we simply cannot avoid continuous spacetime.

Here, it's the same as with entanglement. The fact that we obtain a probability is already included in the approach to superposition. We have an infinite number of possibilities in the low-dimensional spacetime configurations. The surprise is rather why we can only ever obtain one of them in 3D. This is where our h with the interface comes into play. We only have energy from 3D spacetime density available. One possibility will interact with the measurement in 3D. Which one it will be cannot be determined in advance. That pretty much says everything there is to say about probability. We will discuss how the probabilities influence each other (the interference of the waves) in a later chapter on the mathematics of QM.

Our approach makes the often "strange" behavior of QM very easy to explain.

12 Quantization

We already discussed quantization in Chapter 3 on the limits of spacetime. In Section 3.7.3, the quantum of action h was derived from the low-dimensional limit. There, we only discussed the area that was relevant to the low-dimensional limit. Here, we will add the other properties of QM. Therefore, this basic element, based on my subjective selection, comes at the end.

Unfortunately, the quantum of action h is not sufficient for quantization in QM. An important aspect is still missing. On the one hand, we must discuss that in our spacetime, gravity can never be represented by exchange particles. On the other hand, we must discuss why it only works in QM via exchange particles. But then again, it does not work in entanglement.

As always, we start with the simple things and summarize Chapter 3 for the interface.

12.1 The low-dimensional limit

The amazing thing about our approach is that we necessarily start with continuous and differentiable spacetimes, and in a single spacetime there is no infinity, no zero, no singularity, and no quantization. However, the interaction across the dimensional boundary generates the familiar QM. Here are the key characteristics of the boundary again:

- Since we are leaving 3D spacetime, time cannot be transferred via the interface. Time exists separately for each spacetime.
- Since no time is transferred, the overlap between spacetimes is always only space.
- Since no time is transferred, no energy = spacetime density can be exchanged. Only extrinsic deformations or an image as a black hole in 2D are possible. The image as a black hole is a rest mass for us. Energy without the temporal component.
- Since we perform the measurement in our spacetime, all interactions from 2D must be carried out with the Planck values characteristic of our spacetime, and the quantum of action is created.
- We cannot directly recognize geometric characteristics as such from 2D and give these properties new names such as spin, charge, etc.

The most important formula for us here is: $l_P * m_P * c = h$ as the quantum of action and without the dimensional transition (the speed of light) as Compton wavelength (state) then $l_P * m_P$. For the Compton wavelength, only the division into mass and change in wavelength can be divided differently in the low-dimensional. However, the state after the process (collision) in our spacetime must always be Planck mass * Planck length. The process itself can occur in the size of h or a multiple thereof. The interface does not allow for anything else. The geometric characteristics in 2D play almost no role here. We can only determine spacetime density, and this spacetime density must always adhere to h when changing from the low-dimensional. We don't want to dwell on this any further and will move on to the new and exciting topics.

12.2 Interaction in Gravity without Exchange Particles

In our spacetime, there can be no exchange particles for gravity. The graviton, desired by many, is not possible in DP. Particles, regardless of their form, only arise via the low-dimensional interface. Gravity is a deformation of spacetime itself without changing the spacetime density. Gravity and also the dissolution through the opposite deformation thus have no influence on spacetime density. Therefore, they also have no influence on a low-dimensional image. The exchange particle for gravity would have to be a real 3D particle. This presents us with two problems:

- The interaction of an exchange particle with spacetime itself
- The transmission of a change in spacetime requires energy

In DP, gravity continues to be a deformation of spacetime. Then the graviton would have to interact with spacetime itself. How does gravity then get an infinite range? The graviton can interact with spacetime immediately after the spacetime density. How are the gravitons supposed to know that many close to the spacetime density and few further away have to interact with spacetime?

In an electric field, photons must react to another electric field. If there is none, then the range is infinite. With the graviton, however, spacetime is always present as an interaction partner. You can twist and turn this as much as you like. The idea of an exchange particle for gravity and a geometric mapping in spacetime itself are mutually exclusive.

The next problem is energy. Mass, charge, etc. differ for each exchange particle. But all exchange particles transfer energy. With gravitons, it is not clear where this energy should come from. With photons, the energy comes from the change in state of the spacetime density. The electron can change its orbital or its spin. It can also come from a momentum that changes during scattering. In gravity, the change in the energy of the spacetime density from one spacetime curvature to another is zero. Where should the energy of the exchange particle come from and go to? But an exchange particle without energy also makes no sense.

More than two points could be mentioned here. However, the above discussion should make it clear: in DP, an exchange particle for gravity is not possible.

12.3 Interaction in low dimensions with exchange particles

Then we must continue with the opposite here. Why can all state changes in low dimensions occur only and exclusively through exchange particles? As always, this is due to the limits of spacetime. In low dimensions, we always have separate spacetimes.

If one spacetime produces an effect through a special spacetime geometry, the other spacetimes cannot react to it on their own. Two separate 2D spacetimes can overlap at most via a 1D spacetime. The overlap of spacetimes always occurs at (n-1) spatial dimensions. However, we cannot map spacetime density in 1D. The two spacetimes themselves cannot communicate directly with each other. Here, an exchange particle must take over this interaction. However, an exchange particle is nothing more than a 2D mapping.

The whole thing can only work if these 2D spacetimes are connected via a 3D spacetime. Without this higher-dimensional spacetime, there can be no exchange particles. In addition, there must be a change in the state in the 2D mapping. This means that when, for example, an electron reacts to a photon, these two separate mappings become a new mapping in a 2D spacetime. The photon with its energy in 3D is depleted. More on this later in the section on interactions. For now, it suffices to say that an effect between the separate low-dimensional spacetimes themselves only works via separate exchange particles.

12.4 Entanglement again

In gravity, there can be no exchange particles, as this is a change within spacetime. In QM, all effects are an exchange of separate spacetimes, which in turn can only exchange an effect through a 2D image. The images in 2D are fixed. Nothing happens within 2D. The image in 2D must be recreated with each interaction.

Now the idea behind entanglement comes into play again. In entanglement, the mappings in 2D are identical. If this mapping changes, then these superpositions change without the exchange of a particle. Therefore, the reactions are without an exchange particle and thus without information.

12.5 Gravitational waves

Hey, we still have gravitational waves. They have energy and change gravity. Isn't that what we were looking for? A clear yes and no!

12.5.1 Description of gravitational waves

Let's first take a look at how a gravitational wave is generated and what it is. A gravitational wave is triggered by the acceleration of mass. By any acceleration of any mass. Even when I'm just typing on the keyboard, I'm accelerating a small mass of my body. This triggers gravitational waves. These are extremely weak. Here you have to remember the motivation for the DP right at the beginning. These are the 10^{42} difference between gravitational force and the next strongest force, electrical force.

When we apply acceleration to an object, we change the spacetime definition of that object in a certain direction. This means we change the distribution of spacetime density across spatial dimensions. This is a shift in spacetime density for the object, and gravity reacts to it. Energy or spacetime density is not lost and can only shift. It shifts away from one spatial dimension and towards another.

During this process, the object changes its state of motion. This means that the object is no longer where the change took place. Part of the change remains at a spacetime point where the spacetime density no longer exists. This means that part of the energy of the change is retained at that spacetime point. However, the reason for the change no longer exists there. The change propagates as a spherical surface through spacetime at the speed of light. In the process, the energy is greatly diluted. We do not measure energy, but rather the resulting gravitational wave. In the gravitational wave, we see the shift of energy to the spatial dimensions.

12.5.2 Gravitational waves as exchange particles: Yes

Information is exchanged via energy. This sounds like exchange particles, and in principle we could see it that way. However, the exchange particles of QM are always exchanged between separate spacetime configurations and not within a spacetime. Our spacetime is therefore a very talkative object. Any shift in spacetime density between the spatial dimensions is made available to the entire spacetime via gravitational waves. More exchange of information is probably not possible.

12.5.3 Gravitational waves as exchange particles: No

Something is happening, but not what we would expect for an exchange particle. As just mentioned, this is not an exchange between spacetimes. The gravitational wave has a clear sender, but no clear receiver. In QM, the exchange particle is completely absorbed by a receiver. Here, the receiver is the entire spacetime, without the gravitational wave being absorbed. It only thins out.

12.6 Higgs boson

What about the Higgs boson? It is supposed to give elementary particles their mass. Gravity reacts to this. Is the Higgs boson then something like the graviton? Yes, but not for gravity. We will discuss the Higgs boson in more detail again in the section on exchange particles. For classification purposes here, it is sufficient to view the Higgs boson as an exchange particle between 3D spacetimes. We have black holes, which means we are embedded in a 4D spacetime. This means that there are an infinite number of separate 3D spacetimes. Like 2D spacetimes, these must react with exchange particles. This is what our Higgs boson will do. However, the reaction is not to gravity, but to spacetime density between the 3D spacetimes.

Therefore, it appears that the Higgs boson assigns the property of mass. It is the only true 3D boson we know of. However, it is not an exchange particle for gravity within a spacetime.

12.7 It also works without quantization

We often hear statements such as: "In QM, everything is quantized." Unfortunately, this statement is incorrect. Even in QM, the representation of a property can be continuous. In the worst case, it can be mixed: continuous and quantized, e.g., in the case of different energy levels in the representation of momentum. In fact, this is one of the reasons why mathematics in QM is so difficult. If everything were always quantized, it would be easier.

Let's take the binding energy of an electron to its atomic nucleus as an example. As long as the electron is not "captured" by the atomic nucleus, the electron's energy spectrum is continuous. There is no quantization. Of course, the momentum of the electron is in 3D and is not subject to quantization. How much energy is contained in the momentum is not quantized. The situation is completely different when the electron is "captured" and must form a common state with the atomic nucleus. Then the atomic nucleus and the electron must undergo an adjustment at the 2D level. You probably remember that excess energy from the overlap of spacetime densities must be released. This release takes place via another 2D mapping. This means that all participants must redistribute themselves across the dimensional boundary. This can only be done by quantization.

As a simple rule of thumb, we can note that

- If the state of the participating spacetime densities must be redistributed at the 2D level, this always occurs via quantization.
- If the involved spacetime densities remain as they are, no quantization takes place.

Here, too, our approach keeps the basic concept of QM very simple.