Heinz Heinzmann

The Structure of Reality

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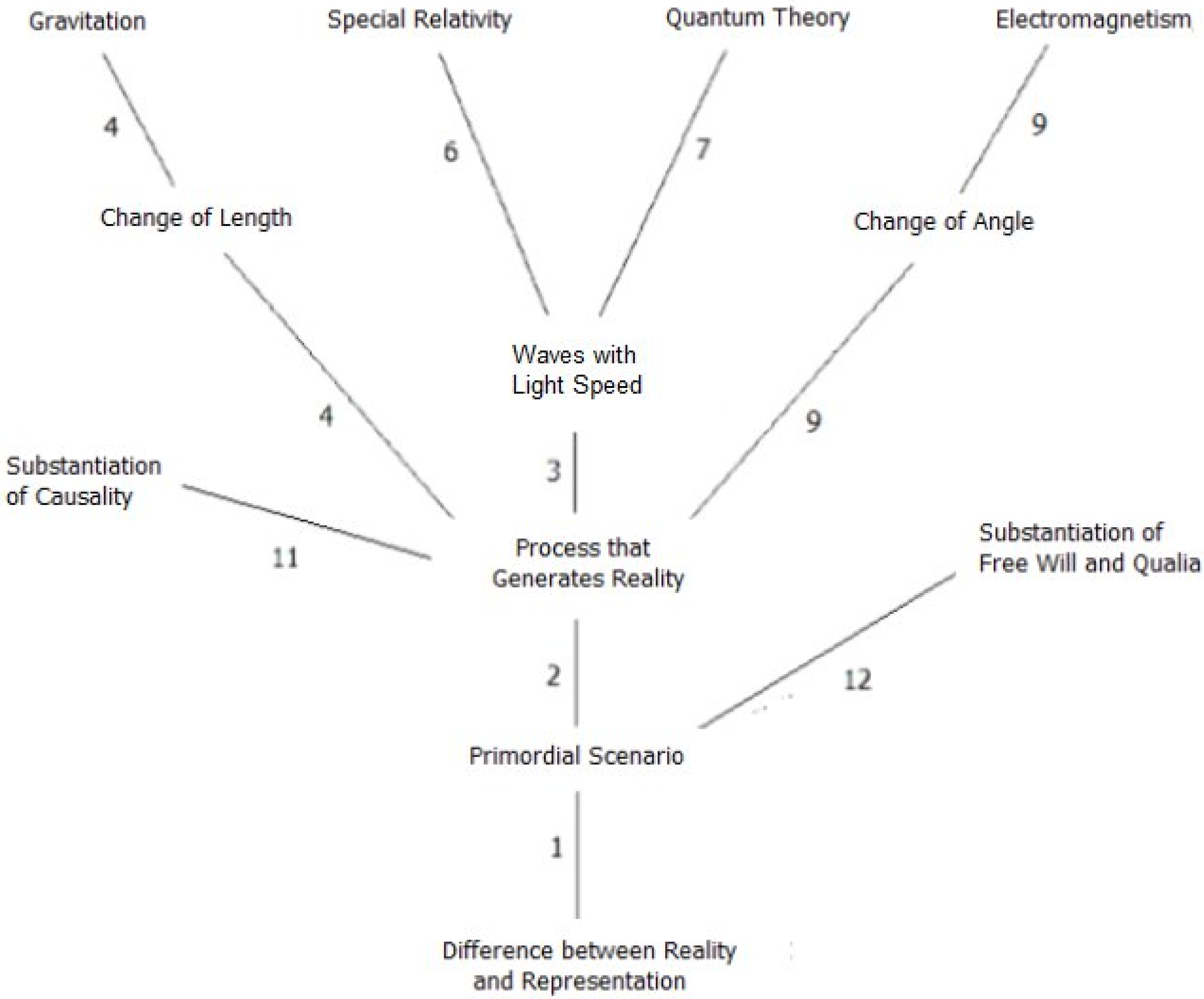
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Preliminary Report

At the beginning of my physical research, there were two questions: "What *really* happens in the double-slit experiment?" and: "*Why* does reality obey the time relationships determined by light signals?" – or, to put it more generally: "How can the formalisms of quantum theory and special relativity be explained *and* understood?"

Having managed (to my great surprise) to answer these questions in a reasonable and, I think, convincing manner, I found myself in a strange position; after just a few argumentative steps I had left the area of the usual interpretations behind me, and finally I had taken a position far outside the conceptual network that standard physics spreads over reality.

At first, however, my explanations were incomplete. So e.g. the question: "What actually oscillates in the Schrödinger equation?" remained unanswered. This question, however, cannot be clarified in the relativistic and quantum mechanical scenarios themselves – for this it is necessary to analyze the preconditions of reality and its description.

Ontological reflections on the primordial basis of reality led me to an equation that is to be understood as description of the process that produces reality.

It reads as follows:

The spatial change in the metric density of space is equal to the temporal change in the metric density of time.

At first I wasn't sure how to assess this philosophically motivated equation. I was inclined to take it for a glass bead game – and it would probably have stayed that way if it had not turned out almost immediately that, starting from there, you can arrive at a theory of gravitation *and* a theory of electromagnetism in an extremely short and simple way, whose results – at least according to some initial tests – fully agree with the results of the general theory of relativity and with the quantum mechanical atomic model.

I therefore assumed that I had discovered a new, simpler approach to the known theories, and found this agreement to be a wonderful confirmation of the fundamental equation and of my relativistic and quantum mechanical explanations. In my mind's eye was the image of two logical-mathematical bridges stretching from my equation to general relativity and quantum theory.

This description corresponds to the state of my knowledge at the time I finished my book *The Concept of Reality* more than 10 years ago. Since then, however, there have been some fundamental changes, which I will now briefly report on.

(I refer to my theory of gravity as *metric-dynamic gravity*. In the following, MDG stands for this theory, GR for general relativity, EM for electromagnetism.)

In the spherically symmetric case of a single non-rotating mass, i.e. in the case of the Schwarzschild solution of the GR, MDG and GR actually agree completely. This can be demonstrated using the well-known tests of the GR. Surprisingly, this agreement holds *only* in this case, and also here only with regard to the exterior solution.

If the system under consideration contains several masses, however, the two theories differ, and to a much greater extent the difference of the results depends on the magnitude of the total torque of the system.

In the gravitational field of planets and in solar systems – due to the dominance of the central mass and the relative smallness of the total torque – this deviation is so small that it can almost always be neglected; But this is not the case for galaxies: here, most of the total mass is off-centre, and the total torque is enormous in almost all cases.

Under these conditions, from the MDG a significantly higher rotation speed of the outer regions of galaxies follows than from the GR. So there is the possibility that dark matter can be omitted to explain the high rotation speed.

In summary: MDG is not, as I originally assumed, just a new path to GR, but a completely new theory.

The same applies to the EM, albeit with the essential restriction that – at present – my version is not a theory but only a concept, although this concept is at least sufficiently worked out to enable the construction of an atomic model that corresponds to the quantum mechanical model.

Despite this incompleteness, it can be claimed with certainty that my version of EM is also a new theory and not just a new way to the existing theory. The main reason for this is that my concept of EM – just like my concept of gravity – is of metric-dynamic nature, in other words: that the EM is also based on changes in space-time. In standard physics, this is impossible, because there the GR claims space-time *exclusively* for itself.

It can therefore be assumed that the elaboration of the metric-dynamic version of EM will lead to significant changes, just as is the case with gravitation.

So this is the first and most important reason why I am now presenting my physical-philosophical approach to the description of reality once again: in continuing the work on my theory of gravitation, it has become clear to me that my representations of gravitation and electromagnetism are not just new approaches to the existing theories, but rather completely new, independent theories which lead to important new results.

The second reason is that I now see some of the trains of thought presented in the "Concept of Reality" much more clearly, including the one that concerns the essential characteristic of my description system and which, at the same time, is essential for assessing the position of this system within the history of physics – or let's say better: within the development of the theoretical basis of physics.

What is meant by this can be explained using the example of gravitation:

Newton's theory is ***purely*** *mechanical*, Einstein's theory is *mechanical* ***and*** *metric*, my theory is ***purely*** *metric*.

And that's exactly how it is also in general:

The scientific description of nature begins with the quantification of experiences about the behavior of objects – this is the area that I call *mechanical*. For one part of physics – that of gravitation – Einstein connected this mechanical domain with the metric of space-time, but the rest of physics remains (in this sense) purely mechanical. For example, electromagnetism works ***in*** the altered space-time, but not ***through*** it.

This is the reason for the incompatibility of the theories of gravity and electromagnetism. Due to the structure of my description of nature, this problem disappears: both theories are metric, and both arise from the same source – they follow from the fundamental equation and the (in each case) simplest possible metric assumption.

Furthermore, as I will show, it is only through the complete metrization of physics that it becomes possible to establish causality and in this way understand the existence of natural laws; In what I call "mechanical" there are only *falsifiable regularities*, but the *lawful causal connections* lie exclusively in the metric foundation of reality.

Finally, there is another reason for resuming my project – a motif that has accompanied me since the completion of my last book. I was surprised myself by how my physical-philosophical project developed and expanded. In the form it has taken in *The Concept of Reality*, it already represents a scientific description of reality on a new foundation, and in the meantime it has also turned out – as just mentioned – that not only the theoretical basis but also the theories themselves are completely new and only approximately agree with the known, proven theories.

There is probably no argument that could be strong enough on its own to justify such a fundamental and comprehensive change. In order to accomplish this, it is necessary to capture a larger part of what this new description system achieves as a whole: its incredible abundance of insights and explanations, which is most noticeable where there has previously been hardly more than barely hidden perplexity – such as when interpreting quantum mechanical scenarios or also with the current problems related to dark matter and dark energy.

It is precisely this need to present my system in a way that allows an immediate grasp of several complex relationships that gave me the idea of representing its logical structure through a simple sketch – the sketch that can be found at the beginning of this document. I think it is largely self-explanatory: its tree structure indicates that the logical steps lead from bottom to top and from inside to outside. Each of these steps represents not only a deduction but also an explanation, in other words: a conclusion that goes beyond the purely formal. Each step presupposes all previous ones.

The structure of the book follows the structure of the sketch: each chapter is assigned to a connection between two subjects; the chapter numbers correspond to the connection numbers.

Since even the simple pictorial representation threatened to become confusing, I created two versions. I will conclude this short introduction with the second, slightly more complex variant. It is still not complete, but at least contains most of the important results.

Here is another point where an explanation seems appropriate:

Many of the following arguments refer to physical issues and discussions that were current a long time ago – perhaps 30, 50 or even 100 years. However, they are not intended as excursions into the history of physics, but rather as analyzes of decision-making situations in which the correct solutions were not discovered and wrong paths were therefore taken – with negative consequences for current physics.

In fact, this is the case with almost all important physical theories: it applies to the special and general theory of relativity, but especially to quantum theory, where a number of unfortunate decisions occurred – for example with the photoelectric effect, the Compton effect, the interpretation of the measurement process as well as with the interpretation of the formalism in general, in the refutation of the proposal of Einstein, Podolski and Rosen by the proof of John Bell, etc.

In all these cases I will try to clear up the misunderstanding, present the overlooked alternative and argue for this alternative. I hope I succeed to display the respective solutions as clearly as I see them.

All alternative solutions are elements of the fundamental change that was discussed previously: the path to a metric justification of the entire physics, which – in my opinion – is essential for our understanding of nature.

It is only at the end of these introductory remarks that I come to the philosophical part of my book. This corresponds to the path my continued search has taken me:

At first, as described, I only had open physics questions in mind. However, the expansion of the scientific world view that was necessary for the desired answers turned out – completely unexpectedly – to be necessary and sufficient to clarify some of the most important philosophical problems.

I end with an announcement – with a list containing the essential philosophical insights for which the new, expanded view of reality is required:

Substantiation of causality

Substantiation of free will

Substantiation of the existence of qualia

Impossibility of robot consciousness

Impossibility of the identity of concept and object

Impossibility of the identity of mathematics and reality

Justification and determination of transcendence and meaning

Notes:

Basically, in this writing I want to say the same as I did in *The Concept of Reality*, but taking into account the changes that have occurred since then, and with particular attention to the consistent logical structure. That's why I will take some sections of the text – sometimes even large parts of chapters – from the *The Concept of Reality,* in the best case because I still think it's good enough, but sometimes just because I haven't thought about it since.

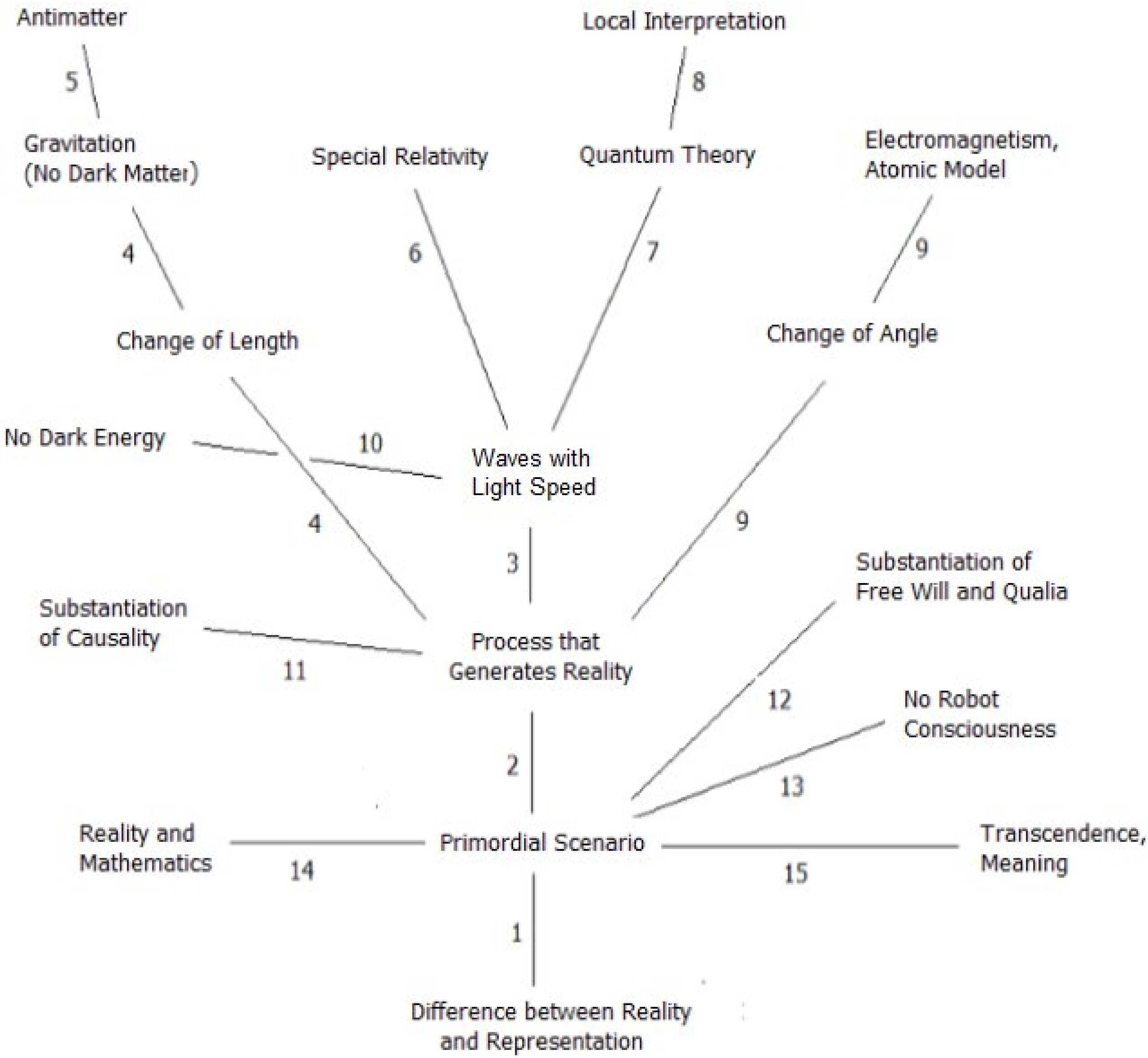
In most cases I will not provide an introductory description of the physical facts being analyzed but will assume knowledge of them. The hope of providing insight through short introductions to an audience that is far removed from physics is an illusion.

Since it is my intention to design the individual chapters in such a way that they are largely independent and can be understood on their own, I will often repeat myself – especially when it comes to the basic definitions, prerequisites and assumptions.

To almost all readers – especially to scientists – the beginning of the book will seem completely foreign, because it combines ontology and physics. I am aware of this difficulty, but I cannot avoid it because it is the basis of the entire description system. I can only point out that in this way an incompleteness in the scientific view of reality is eliminated, and that this correction proves to be extremely fruitful for physics and philosophy.

If someone is only interested in the physical part of the book, there is also the option of starting with Chapter 4 on gravity. But it would then make sense, in advance to read the Postscript, where the connection between special relativity, gravity and quantum theory is briefly presented, which becomes apparent in my description of reality.

(One final note: of course there are also numerous cross-connections. However, integrating them into the sketch would not have led to more clarity, but rather to confusion.)



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Difference between Reality
and Representation

1. Difference between Reality and Representation → Primordial Scenario

If there were a list in which all the issues that have so far remained unnoticed were ranked according to their importance, then the difference between reality and representation presented below would have to take first place. Despite its fundamental importance for philosophy and natural science, it has almost completely escaped both philosophical reflection and scientific research.

It reads:

There is a fundamental difference between a really existing system and its representation: the really existing system is* active*, but the representation is* not active*.

Everything that exists exerts effects on other things. A thing that does not interact with anything else does not exist.

Therefore to really existing things the following applies:

Really existing things are **active** *by themselves* or *out of themselves*; they *influence* their environment.

By contrast, objects in a representation – for example in a mathematical or a verbal description, or in a train of thought, or in a model, or in a simulation – are **not active**.

An example: the earth. The *real* Earth *always* exerts gravity – it only exists *with* gravity. However, this does not apply to the *described* or *imagined* earth: the imagined moon, which moves around the imagined earth, can be stopped in thought at any time, the equation of the earth and moon system does *not* solve itself, and the same applies to a mechanical or electronic simulation of this system: the simulation is **not active** *out of itself*, it must be *activated* – mechanically or electrically.

Therefore to objects in a representation applies:

By themselves or *out of themselves* they are **passive**.

Effects must come *from* something*;* Really existing objects must therefore have something in themselves that objects in a representation have not.

This difference can be conceptualized in the following way:

Really existing objects consist of substance and accidents.

Objects in a description system consist exclusively of accidents.

Here, the notion ***substance*** stands for that which represents the answer to the question: *"What* do the effects come from?" It will obtain its full meaning only in the course of further trains of thought that will follow later. The same applies to the term ***accidents***; here it simply means *attributes*.

Substance points to *what* things *are*, or rather, what they *consist* of.[1]

The notion *accidents* contains everything that can be said about *how* things behave and present themselves and how they interact with other things.

Substance refers to the *carrier* of the object attributes.

Let us consider a thing *without substance*, e.g. a mathematical object: it consists exclusively of its definition, i.e. of its attributes. A mathematical object exists only *as* its definition; without this it does not exist. Its name is merely the "abbreviation" of its definition, the "placeholder" of its attributes. But there is no "carrier" of the attributes.

For example, natural numbers consist only of the Peano axioms by which they are defined. Every operation with natural numbers refers to this definition. If it is removed, what remains is not objects without definition, but *nothing*.

In other words: reality is structure *and* substance[2], Mathematics is *only* structure – and the same applies to any description system.

In this first chapter we have set ourselves the task of arriving at statements about the logical and ontological presuppositions of reality, starting from the *difference between reality and representation*. I call the entirety of these statements – as far as they are possible for us – the *primordial scenario*.

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[1] Basically, however, all such assignments are problematic. "Consisting of something" seems to indicate something "material" or at least something "space-occupying", which is misleading. It is important to understand that *substance* is a purely abstract concept – an abstraction of *nothing*. What the substance "is" cannot be thought in any way, nor is it possible to "approach" it through analogies or comparisons. It cannot be defined in terms of content, but only in relation to its position in the description of reality.

[2] Here, "structure" can be replaced by "information": Information also needs a carrier.

1.1. Primordial Scenario

For us, everything that exists consists of two completely different elements, which we have called *substance* and *accidents*. From their conceptual definitions the following statements can be derived.

Substance is the *carrier* of attributes. It is what remains after all attributes (interactions) have been removed mentally. It itself has no attributes. Therefore it is *indistinguishable*, which means: it is *the same* for all objects.

From this follows that we must understand it as a precondition for everything that exists.

Substance is what all things consist of. But what a thing consists of must also be what it came into being from. We must therefore understand substance as the *origin of everything that exists*.

This means:

Substance is the origin of reality.

It produces reality. It is what things arise from and what they are made of. It is what makes real things *active*.

Substance is not an object. Since our thinking cannot leave the realm of relationships between objects, it is inaccessible to our thinking. Our descriptions of reality refer exclusively to accidents. So only a part of what an object "is", is accessible to us. The other part is unthinkable.

In being itself, substance and accidents are *inseparably* linked – they form an inseparable unity. Just like the substance itself, this inseparability is of a *metaphysical* nature, and by that I mean that it cannot be thought by us.

In themselves, things are not divided into substance and accidents. *For us*, however, this dichotomy is unavoidable. Our language and our thinking are not suitable for grasping the inseparable unity of substance and accident: *for us*, the relationship between substance and activity is always that of subject and predicate – the subject can be active or inactive. For the substance, however, this alternative does not apply.

Therefore, substance is not ***something that*** is active, it ***is activity***.

To inseparability and activity the same applies as to the substance itself: although we can recognize that they "are there" and name them, what they really are remains hidden to our thinking.

But even if we cannot think the substance as what it "is", there still is – as has been shown – the possibility to say something *about it*.

The following three statements are required for the physical part of my presentation. They form the starting point of the next chapter:

(1) *Substance* produces reality. It is the source of the activity of things. Therefore we must also attribute activity to it itself. *Substance* **is** *activity*.

(2) The substance itself has no attributes. So *in itself* it must be indistinguishable.

(3) That the substance is *active* means that it abolishes its indistinguishability: Substance is *that-which-changes*. In changing itself, the substance creates differences and thus rises to existence.

Addendum:

From the definition of the substance it can also be deduced why something exists at all, i.e. why there is *something* and not *nothing*. Since this derivation stands on its own and is not necessary for further conclusions, I will remove it from the general course of my argument and present it in the form of an additional comment.

Let us ask ourselves again: What is the substance, conceived as carrier of the attributes of things?

The carrier of an object's attributes is defined as that from which the effects emanate, in other words: as what the object is *without* the accidents, or in other words: as what remains when all interactions are (mentally) removed.

However, *interaction* is a necessary prerequisite for attributing *existence* to an object: something that does not interact with anything else does not exist. Thus the substance does not meet the criterion for existence.

So let us first note:

The substance ***does not exist***.

On the other hand applies:

As stated above, from a mathematical object no effects emanate; *out of itself* it develops no activity. Therefore *nothing* (or just an empty term, or a name) remains of a mathematical object when the attributes are removed.

But from an existing object effects *must* emanate. However, from something that does *not exist* no effects can emanate*: Nothing* cannot be carrier of attributes.

So let us secondly note:

The substance ***does not not-exist*** either.

Thus the following applies:

The substance does neither exist nor not-exist.

We have determined substance as that from which everything that exists arises. Therefore applies:

The origin of being does neither exist nor not-exist. It is neither something nor nothing.

Everything that exists can *be or not-be*. This alternative does not exist for the *origin of everything*, which itself is no being. But there is no further alternative *behind* the alternative of being or not-being. Therefore, that which is not in the alternative of being or not being is ***necessary***.

This means:

The origin of everything is necessary, and with it at the same time that what emerges from it, that is: being.

Because if there were nothing, then the origin of being would not exist either, and that was previously ruled out.

<u>Note:</u>

We have called the substance *that-which-changes*. On the other hand, we have determined it to be *indistinguishable in itself*.

But if it changes, it can no longer be *indistinguishable*.

This contradiction is resolved as follows:

If we conceive substance as that which produces reality, then we are considering its *being-in-itself*. It is the substance *in itself*, which *before* (in an ontological sense) all existence, as *neither-existent-nor-non-existent,* is indistinguishable and which rises to reality as *that-which-changes*. But *in itself* it always remains substance – it "is" the reality. The unfolding reality is nothing other than the substance in its constant change. Reality *is* substance.

For us, however, being necessarily is divided into substance and accidents. Since what happens is only accessible to us through accidents, any *change* is – *for us* – transferred to the realm of accidents. As a result, when we look at being, *for us* the indistinguishability of the substance remains, but its *change* is lost.

2. Primordial Scenario → Process that Generates Reality

In this chapter, our goal is to put the statements about the substance, which we established in the previous chapter, into a mathematical form:

(1) *Substance* produces reality. It is the source of the activity of things. Therefore we must also attribute activity to it itself. *Substance* **is** *activity*.

(2) The substance itself has no attributes. So *in itself* it must be indistinguishable.

(3) That the substance is *active* means that it abolishes its indistinguishability: Substance is *that-which-changes*. In changing itself, the substance creates differences and thus rises to existence.

According to (1), substance is the *origin of reality*.

Given this assumption, how can we get to a *description of reality?*

By changing from the *origin of reality* to the *origin of the description of reality* – or, to put it philosophically: by changing from what the substance is *in itself* to what it is *for us*.

Our task is therefore to determine that which has the same status for the description of reality as the substance has for reality itself.

What is the substance? The logical and ontological presupposition of reality.

What are the logical and ontological presuppositions of the description of reality?

Space and time.

This means: Space and time are for the description of reality the same as what substance is for the reality itself. *For us*, substance is space and time.

According to (3), substance produces reality by changing itself. Therefore, we begin building our description of reality with the description of a change.

The first question is: *What* is changing?

That which the substance is *for us:* space and time. (Since we are still *before* all existence, it *can* only be space or time that changes.)

The second question is: *How* do we represent this change?

According to (2), the substance is *in itself indistinguishable*. So there is no structure and no memory. This means that every temporal change can only relate to the previous moment, and every spatial change can only relate to an immediately adjacent position. Changes must therefore be represented as differential quotients.

Let us start with a change of space. How can space change in the description? Only by changing its length or angle.[3]

First to the change of the length measure:

We define σ, the ***metric density of the length***, as follows:

Let r be a spatial coordinate. Then

$$\frac{dr}{\sigma(r)} = dr' \qquad \Leftrightarrow \qquad dr = \sigma(r)\, dr'$$

– where r' denotes the same spatial coordinate after the metric change. σ is dimensionless.

So we set for the first change:

$$\text{Change 1} = \frac{d\sigma}{dr}$$

However, it is clear that *one* change is not enough to establish a description. Since without change there would be Nothing, something must follow from the first change, and this consequence must again be a change of the substance itself, i.e. of space or time.

Our first change was a change of space. As second change, we need another change, different from the first, that is: a change of time.

[3] As it turns out, changes in the length measure lead to gravitation, changes in the angle measure to electromagnetism. This will be shown in Chapters 4 and 9.

Therefore we set for the second change:

$$\text{Change 2} = \frac{d\zeta}{d(ct)}$$

where ζ denotes the ***metric density of the time t***.

For dimension reasons – which will become clear below – ct must be set instead of t, where c is a constant that has the dimension of a velocity. ζ is dimensionless.

Based on the statements about the substance, we have now determined two changes, assuming that the second change follows from the first. However, since it still holds that without change there would be Nothing, we are again compelled to continue the chain of changes. In our scenario only space and time can change, and both we have already used. This means that the chain of changes that follow from each other can only become perpetual if from the second change in turn follows the first one. We thus get

$$(\text{change 1} \Rightarrow \text{change 2}) \;\; \textit{and} \;\; (\text{change 2} \Rightarrow \text{change 1})$$

It follows

$$\text{change 1} = \text{change 2}$$

So the equation we have arrived at is

$$\boxed{\frac{d\sigma}{dr} = \pm \frac{d\zeta}{dct}} \qquad \text{or} \qquad \boxed{\frac{d\sigma}{dr} = \pm \frac{1}{c}\frac{d\zeta}{dt}} \tag{0}$$

The spatial change of the metric density of length is proportional to the temporal change of the metric density of time. Proportionality factor is the velocity c.

Mathematically, this is just an equation. Ontologically, however, it is what the process of generating reality is *for us: the law from which reality is woven*, or, to put it another way, *the fundamental equation*, where "fundamental" means that everything that can be derived at all must be derivable from it.

In equation (0), σ has two interpretations. Hitherto we have only determined the consequences of the change of the *length measure*. Now we need to do the same for the change of the *angle measure*.

So we now interpret σ as ***metric density of the angle*** and define it as follows (to avoid ambiguity, we denote the angle density by η instead of σ).

Instead of the definition $$\frac{dr}{\sigma(r)} = dr' \quad \Leftrightarrow \quad dr = \sigma(r)\, dr'$$

we therefore get $$\frac{d\alpha}{\eta(r)} = d\alpha' \quad \Leftrightarrow \quad d\alpha = \eta(r)\, d\alpha'$$

Then Equation (0) turns into

$$\boxed{\frac{d\eta}{dr} = \pm \frac{d\zeta}{dct}} \qquad (0')$$

In order for equations (0) and (0') to serve as basis for a physical description of reality, they must be transformed into *dynamic equations* – without motion there is no change. The easiest way to do this is to interpret the dimensionless quantity ζ as quotient of two velocities. One velocity is already present in (0) in the form of the constant c. So we also use c in defining ζ. We set:

$$\zeta = \frac{v}{c}$$

c is the constant, v is the variable.[4] Thus equation (0) turns into

$$\frac{d\sigma}{dr} = \pm \frac{d\frac{v}{c}}{d(ct)}$$

$$\boxed{\frac{d\sigma}{dr} = \pm \frac{1}{c^2}\frac{dv}{dt}} \qquad (1)$$

[4] Setting the metric density of time as v/c is primarily motivated by the fact that the speed v then contains the entire metric information, i.e. the information about how lengths and times change depending on v. This leads to the relativistic structure of reality.

A sketch for illustration. Let A, B and C be three points along the coordinate r. The distances between A and B and between B and C are equal to 1.

(S1)

Here, σ is constant. Now we change the situation as follows:

(S2)

The *distances* have remained equal to 1, but the *length of the measuring unit* has increased between A and B and decreased between B and C.

This means: the *metric density* σ is greater between B and C than between A and B.

A, B and C are not to be understood as *points of space*, but as *boundary points of measurement intervals:* a distinction must be made between *space itself* and its *metric structure.*

(Why this distinction is necessary, will become clear in Chapter 4 on gravity.)

What results in (S2) for B? According to (1), a flow arises which I call ***metric flow***, i.e. B experiences an acceleration for which – because of the possibility of positive and negative sign in (1) – initially the direction is still open. We let us guide here by the idea that B is accelerated back to the center of AC.[5] This means that in (1) the negative sign has to be chosen:

$$\boxed{\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}} \qquad (1)$$

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[5] The other case appears with antimatter. (See Chapter 5.)

Note the difference between the metric density σ and the "normal" density ρ: In the case of ρ there is a fixed value ρ_0 so that the magnitude of the acceleration is determined by the magnitude of the deviation from that value. So here, there is an *absolute* measure, ρ *has a memory*. If σ corresponded to a normal density ρ, then the amount of the change in density would depend on the initial density.

To eliminate this dependency, instead of (1) would have to be set

$$\frac{d\rho}{dr}\frac{1}{\rho} = -\frac{1}{c^2}\frac{dv}{dt}$$

In contrast, the metric density σ cannot have such an absolute value – it would be nonsensical to ascribe an (absolute) density to a continuum. So there is no absolute measure here, and the factor $1/\sigma$ is omitted; σ *has no memory*. There is no absolute metric density, there are only density relations.[6]

In the same way, as we have just transformed (0) into a dynamic equation, we must also transform equation (0'). Instead of

$$\zeta = \frac{v}{c}$$

we now have to set

$$\zeta = \frac{w}{c}$$

– where w is a velocity *orthogonal* to r. (Why this is the case, will be demonstrated immediately afterwards.)

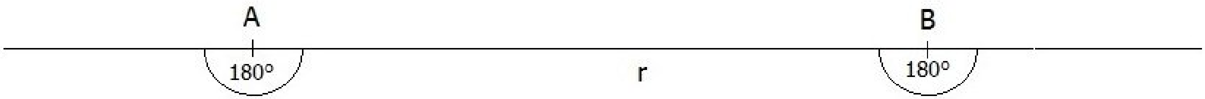
Equation (0') then turns into

6 From this also follows that there is no absolute size, only size relations. This has far-reaching consequences for assessing the origin of the universe and the evolution of its size. (See Chapter 10.)

$$\frac{d\eta}{dr} = \pm \frac{d\frac{w}{c}}{d(ct)}$$

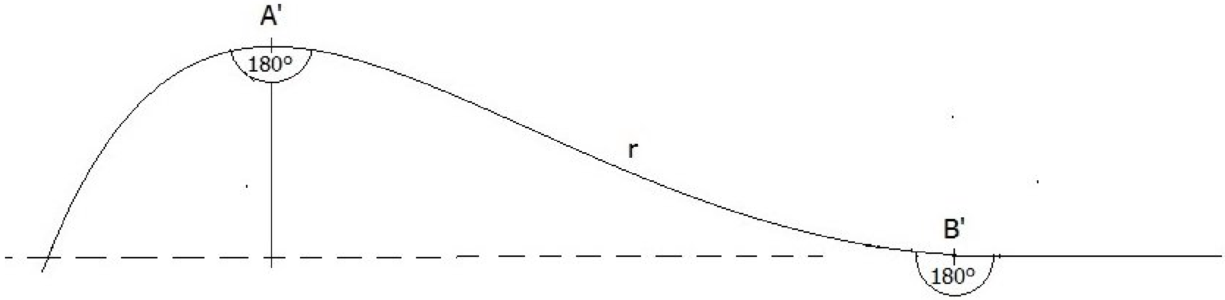
$$\boxed{\frac{d\eta}{dr} = \pm \frac{1}{c^2}\frac{dw}{dt}} \tag{1'}$$

Also here a sketch for illustration: A and B are two points on the coordinate r. The angles drawn at A and B are 180°:



(S3)

Here, η is constant. Now we change the situation as follows:



(S4)

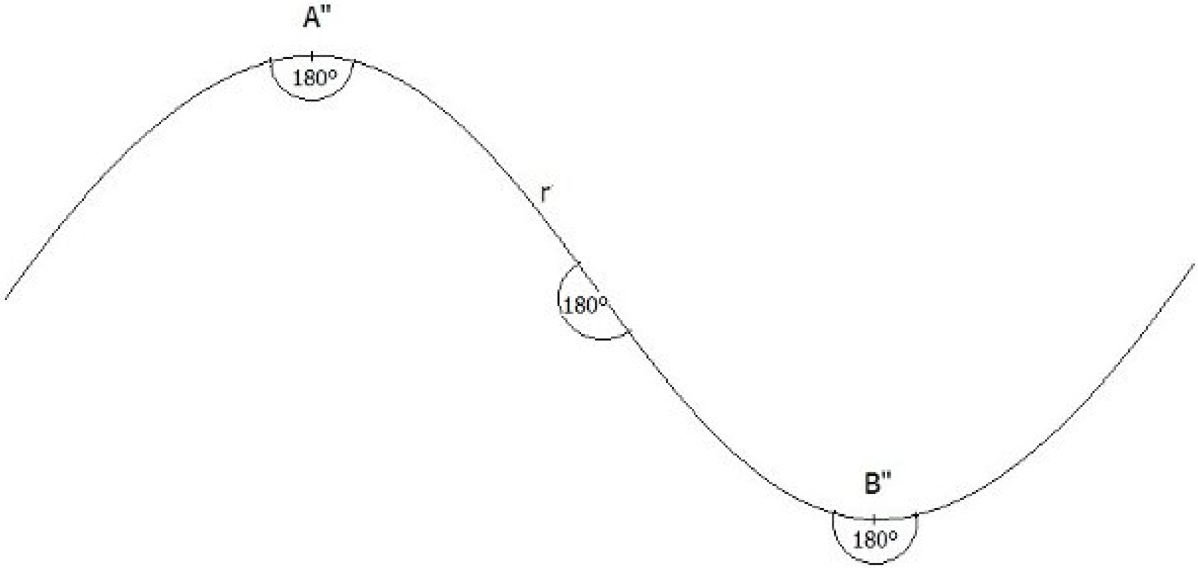
The angles have remained equal to 180°, but the *angle measure* at A' has decreased compared to the angle measure at A. This means: at A', the *metric angle density* η is greater than at A.

In contrast, at B' the angle measure has increased; therefore the angle density is smaller at B' than at B.

What results in (S4) for A'? According to (1'), a *metric flow* arises, so that A' experiences an acceleration, but this time *normal* to r. Here again we assume that the negative sign is to be chosen. It follows

$$\boxed{\frac{d\eta}{dr} = -\frac{1}{c^2}\frac{dw}{dt}} \qquad (1')$$

Subsequently we will derive waves of length density and of angle density. Here is a sketch to illustrate the angle density variant:



(S4a)

The sketch shows that transverse waves can be understood as *waves of the angle density*, if the change of the wave amplitude is interpreted as *metric change of the angle*.[7]

[7] From this follows that electromagnetism can be traced back to metric changes – just like gravitation. (See Chapter 9.)

The metric situation presented in (S4a) can of course also be understood as follows:

(S4b)

This concludes this chapter. The aim was to put ontological conclusions into a mathematical form suitable as basis for physics. The proposition we have arrived at in this way reads as follows:

Reality is a differential web of metric changes in space and time that are mutually dependent. Everything that exists and that occurs – every object, every interaction, every process – is a pattern of these changes.

At this point of our considerations, this proposition is based solely on the analysis of the origin of reality. In the next chapter, we will take a first step to make it more concrete.

Remark:

The question arises as to why we can presuppose mathematics and logic at the beginning of constructing the description of reality. The answer is as follows:

Every beginning of a description of reality must presuppose unproven assumptions. One is necessarily in a logical circle. What is crucial is that

1. this circle is not destructive, and

2. that it is possible to finally recognize the initially unproven assumptions as conclusions from the description system itself and thereby justify and understand them.

A short version of this procedure can be found at the end of Chapter 14.

3. Process that Generates Reality → Waves with Light Speed

The dependency of σ and v, expressed by (1), entails an inverse dependency.

In the sketch (S5), v decreases in flow direction; therefore, in the length element at P, the inflow is greater than the outflow.

(S5)

As can be seen from (S5), it follows

$$\frac{dv}{dr} = -\frac{d\sigma}{dt} \qquad (1a)$$

For comparison, the one-dimensional continuity equation for a length element that is moving with the flow:

$$\frac{dv}{dr} = -\frac{d\rho}{dt}\frac{1}{\rho} \qquad \left(\text{here } \frac{d\rho}{dt} \text{ is the total derivative}\right)$$

The comparison[8] shows, that (1a) applies in general only if $\frac{d\sigma}{dt}$ is understood as total derivative.

However we will differentiate σ only partially with respect to time. Therefore we must presuppose

[8] Also here, the term 1/ρ appears due to the fact that the magnitude of the change of the density depends on the deviation from an absolute standard value. In the case of σ, there is no such absolute scale but only relative changes, and therefore this term is again superfluous.

that the change of σ along r is negligible, and that, accordingly, the total derivative $\frac{d\sigma}{dt}$, which contains also a dependency of r $\left(\frac{d\sigma}{dt} = \frac{\partial\sigma}{\partial t} + \frac{\partial\sigma}{\partial r}\frac{dr}{dt}\right)$, can be replaced by the partial derivative $\frac{\partial\sigma}{\partial t}$.

So we look at the case $\sigma(r)$ = constant and start with a local change of σ or v. The following process will then be determined only by this first disturbance (and not by an already existing r-dependency of σ), in other words: by the equations (1) and (1a):

$$\frac{\partial\sigma}{\partial r} = -\frac{1}{c^2}\frac{\partial v}{\partial t} \tag{1}$$

$$\frac{\partial v}{\partial r} = -\frac{\partial\sigma}{\partial t} \tag{1a}$$

Differentiating (1) with respect to t leads to $\frac{\partial^2\sigma}{\partial r\partial t} = -\frac{1}{c^2}\frac{\partial^2 v}{\partial t^2}$

Differentiating (1a) with respect to r gives $\frac{\partial^2 v}{\partial r^2} = -\frac{\partial^2\sigma}{\partial r\partial t}$

From this follows
$$\boxed{\frac{\partial^2 v}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 v}{\partial t^2}} \tag{2}$$

So we get waves in v whose velocity is c.

Following the same pattern, we get also waves in w:

From the equation
$$\frac{\partial\eta}{\partial r} = -\frac{1}{c^2}\frac{\partial w}{\partial t} \tag{1'}$$

follows $$\frac{\partial w}{\partial r} = -\frac{\partial \eta}{\partial t} \qquad (1'a)$$

and this leads again to the wave equation

$$\boxed{\frac{\partial^2 w}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 w}{\partial t^2}} \qquad (2')$$

Due to the symmetry of the equations (1) and (1a) with respect to σ and v, and also of the equations (1') and (1'a) with respect to η and w, we obtain analogously also *metric waves*:

In σ: $$\boxed{\frac{\partial^2 \sigma}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 \sigma}{\partial t^2}} \qquad (3)$$

And also in η: $$\boxed{\frac{\partial^2 \eta}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 \eta}{\partial t^2}} \qquad (3')$$

Because of $v/c = \zeta$, from (2) follows

$$\boxed{\frac{\partial^2 \zeta}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 \zeta}{\partial t^2}} \qquad (4)$$

In summary: We get waves of the longitudinal metric flow v as well as waves of the transverse metric flow w, and another three types of *metric wave*s – waves in σ, the metric density of the length, waves in η, the metric density of the angle, and waves in ζ , the metric density of the time. All waves have the speed c.

As the name indicates, we identify c with the speed of light.

What is important for the following is:

All these waves are waves in the longitudinal metric flow:

For the waves in σ and v and ζ, this is self-evident, since equation (1a) only applies to a length element that is moving with the flow.

If in equations (1') and (1'a) – which contain the transverse flow w – a longitudinal flow in the r-direction exists, the relationships described by these two equations, which also include the waves in η and w, apply for a system moving with this flow.

What are these waves?

The question arises as to how these different waves relate to standard physics.

Since we identify c with the speed of light, all waves have light speed. So it can be assumed that they are related to light waves, electromagnetic waves and gravitational waves.

However, this connection is not yet apparent.

To demonstrate the fundamental importance that these waves have in the formation of reality, we shall now carry out a brief analysis of the time structure of reality in the next section.

3.1. The Time Structure of Reality

From Einstein we know that time does not – as Newton assumed – "flow uniformly in and of itself and of its own nature, without reference to anything external", but that the results of time measurements depend on the state of motion of the observer. Einstein's analyses rely on signals that enable us to determine the time points when events occur at distant locations.

However, I think that this type of analysis does not go deep enough. Subject of the analysis should not be *signals* that serve to *determine* time relationships, but rather *causal processes* that ***cause*** time relationships. As follows:

If time does not "flow uniformly in and of itself", then every local passage of time, as well as the relationships between these local times, must be caused by something. It is evident that this causation must be attributed to the causal processes by which the objects of reality are connected.

The next step is to understand that the time relationships created in this way depend on the state of motion of the objects.

This requires the following consideration:

We look at two objects. At first they both are at rest. But if they now begin to move along their connecting line in the same direction at the same speed, then the relationship of the local times that apply to them changes – simply because *each* of the causal, time-generating processes that begins at the object in front and ends at the rear one, now arrives at this rear object *earlier* than the same process in the case of the objects at rest, because now the rear object is running *against* this process.

However, this means nothing other than that – with respect to the rear object – the point in time at which the process started at the object in front has now – compared to before – *shifted into the past*.

Obviously, the extent of this shift depends on the speed of the process: the smaller the speed, the larger the shift.

From this, the following – surprising and far-reaching – conclusion can be drawn:

Let us assume that the objects of a system are linked by processes that propagate with the velocity c. Then we get a time structure that is completely determined by c – as it is *in fact* the case.

Suppose now in addition that there are other processes propagating at a different velocity d, which is independent of c. Then these processes create a second time system that is different from the one created by c and independent of it. But that is impossible. The time system must be unique.

From this follows:

***There is only one velocity, namely* c.**

All other velocities must be derived from it.

The simplest form of such a derivation is to assume superpositions of opposing waves. The speed of the superposition then depends on the frequencies of the two waves. We will do this in Chapter 6 and derive the special theory of relativity from it, without assuming the principle of relativity or the constancy of the speed of light for all uniformly moving observers.

So in this sense there is only the speed of light. This conclusion suggests that the light-speed waves that we have derived from our fundamental equation in this chapter are actually *necessary* for the creation and persistence of the structures of reality. However, it is unlikely that they are also *sufficient* for that because they represent only the simplest linear types of waves or processes that can be derived from the fundamental equation.

3.2. What are Objects?

I add another consideration that plays a role in our argument:

Let us consider the subset of elementary objects in the set of all objects in the universe.

According to standard physics, "elementary" means that they cannot be further broken down into objects and processes. So they are "structureless". This in turn means that they are without time.

However. what is itself *without time* – i.e. without change – cannot be the cause of a change that takes place *in time*.

This means:

The causal processes by which the objects are linked cannot *begin* or *end* at the elementary objects. They must *continue into the objects*.[9]

Elementary objects are therefore by no means structureless and timeless – they are also themselves formed from the processes that we have just determined as the processes that create the structure of time, that is: from exactly the different types of metric waves at the speed of light that we have derived in this chapter.

Therefore, the objects cannot simply be placed into the relativistic causal network, rather they themselves – including their internal structure – *must be understood as part of this network:*

"Objects" are also "processes"; They are ***states of spacetime***.[10]

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[9] Of course, this does not apply to objects that are assumed to be point-like.

[10] In the first chapter we stated: Reality itself is substance. *For us*, however, the substance is space and time. From this follows that *for us* reality consists *exclusively* of space and time: whatever exists is a *state* of space-time, whatever happens is a *change* of space-time.

This leads to the following assumption:

Elementary objects are attractors of the dynamics of the metric space-time continuum.

As we will see later, the general rule is:

Objects are attractors of the dynamics of the level of reality from whose elements they are constructed.

The concept "attractor" thus replaces the concept "particle" and becomes the ontological basis for the concept "object". It is of the greatest generality: it is applicable to (almost) everything that exists, from the simplest to the most complex, starting with the "elementary particle" up to the "mental state", the quale.

Remark:

The above hypotheses initially do not change anything about the currently prevailing theories about elementary particles, i.e. about the Standard Model of particle physics. However, they point out that the Standard Model must be viewed as a *preliminary* description system, because it does not contain the fundamental causal relationships.

Whether these hypotheses make sense shall now be checked for the first time when they appear as elements of the argumentative structure in the next chapter on gravitation.

4. Process that Generates Reality ⟶ Gravitation

In this chapter a new view of gravitation will be presented, which I call *metric-dynamic gravitation*. It is based on the assumption that the change in σ, the metric density of length, can be understood as cause of the gravitational acceleration.

We presuppose equation (1):

$$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt} \qquad (1)$$

The change in the metric density σ thus causes an acceleration of the metric flow v.

In the following, we assume a three-dimensional Cartesian coordinate system K. Our aim is to model a spherically symmetric steady state that is characterized in the following way:

The acceleration $\frac{dv}{dt}$ points toward a center, decreases with increasing distance from this center and becomes 0 at infinity. We achieve this by the following metric assumption: (m is a given distance, m > 0)

$$\sigma = \frac{r - m}{r} \qquad (5)$$

– where r denotes the distance from the center O.

The motivation for this assumption will become clear in Section 4.4. As it turns out, (r – m)/r is the metric density in the outer space of a spherical region of space whose radius has been compressed – in this sense *shortened* – by m units. With this, mass is *defined* as metric compression and thus has the dimension *length*.

(5) differentiated by r gives

$$\frac{d\sigma}{dr} = \frac{m}{r^2}$$ From (1) $$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}$$ then follows

$$\boxed{\frac{dv}{dt} = -c^2 \frac{m}{r^2}} \tag{6}$$

If in (6) m is understood as *geometric mass* ($m = \frac{MG}{c^2}$), then the result is

$$\frac{dv}{dt} = -\frac{MG}{r^2} \tag{7}$$

This acceleration corresponds to Newton's gravitational acceleration caused by a central mass M.

We determine the magnitude of the metric flow v. For this purpose, first we transform (1):

$$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt} \qquad \longrightarrow \qquad d\sigma = -\frac{1}{c^2}\frac{dr}{dt}\,dv$$

Since we are determining the continuous approach to the center O, we set $\frac{dr}{dt}$ equal to v.

It follows $$d\sigma = -\frac{1}{c^2}\,v\,dv \tag{8}$$

Integration gives $\sigma = -\frac{1}{c^2}\frac{v^2}{2} + C$ According to (5) $\sigma = \frac{r - m}{r}$

therefore applies $1 - \frac{m}{r} = -\frac{1}{c^2}\frac{v^2}{2} + C$

The integration constant C results from the condition $v = 0$ for $r \rightarrow \infty$.

Therefore $C = 1$

We get $\frac{v^2}{2} = c^2\frac{m}{r}$

and, finally $$\boxed{v \;=\; \pm c\sqrt{\frac{2m}{r}}} \qquad (9)$$

(9) corresponds to Newton's equation for the fall velocity (for the fall from infinity) in the case of a geometric mass m ($m = MG/c^2$).

Here, however, v is not interpreted as *fall speed*, but as *speed of the metric flow*. This must have the same direction as the acceleration in (6). Thus, the negative sign is to be chosen in (9).

So the metric-dynamic gravitation leads to the same results as the Newtonian approximation, if the acceleration of the metric flow is identified with the Newtonian gravitational acceleration.

The question is:

Is this identification permitted?

This question arises because the Newtonian acceleration acts on *objects*, while in the metric-dynamic gravity the *metric flow* is accelerated. Therefore, equating the accelerations occurring in the two theories is only justified if everything that exists participates in the acceleration of this flow.

What we have found so far suggests that this is indeed the case. In brief:

In the Chapter 2, equations (0) and (1) were presented. The considerations on which their specific form is based suggest, at the same time, that they should be interpreted as description of the process from which reality emerges.

Equation (0) means that reality is a web of metric changes in space and time.

Equation (1) states that a metric change in length causes a metric flow that is proportional to the metric density of time.

In the Chapter 3, several types of waves with light speed were derived from these equations, including metric waves of space and time, all of which exist *in the metric flow* v and thus participate in its acceleration.

In the same chapter, in Section 3.1, it was shown that *there is only light speed* and that all other speeds are derived from it. This gives the previously derived waves a fundamental status.

Finally, in Section 3.2, it was argued that these waves also continue into the interior of objects and are therefore also responsible for the creation of objects and their continued existence.

All these conclusions are concretizations and confirmations of the assumption that everything that exists is subject to the metric-dynamic acceleration.

Thus, the just derived acceleration $\frac{dv}{dt}$ applies not only to the metric flow but also to all objects within it, meaning that it can indeed be identified with the Newtonian gravitational acceleration.

However, thus far our representation of the metric-dynamic gravitation is only an approximation, not other than Newton's theory.

The reason for this is that up to now we have not taken into account the metric changes nor the fact that – seen from our coordinate system – the speed of light is *not constant*, since ***the waves with light speed do not travel in our coordinate system but in the metric flow***. (See here.)

Let's denote the system from which we analyze the scenario as S_0.

S_0 *is **not** an observer system* – it is non-relativistic, we look at things (so to speak) "from the outside", but S_0 enables us to get the correct view of what is happening *within the system*, as will be demonstrated in the following (well-known) examples. .

4.1. Light Falls into the Center

The simplest result that one arrives at from this perspective follows immediately from

Equation (9):

$$v = \pm c\sqrt{\frac{2m}{r}}$$

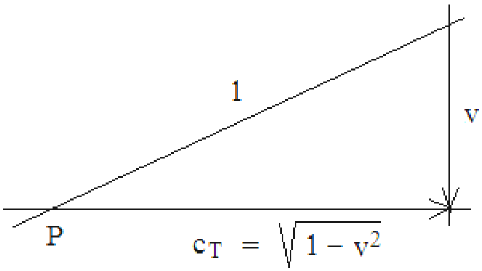
In r = 2m the speed of the flow v is therefore equal to the speed of light. This means that at a distance of 2m from the center, waves with light speed, which move against the flow direction, can no longer get out, but stand still.

4.2. Closed Circular Path of Light

At what distance from the center of gravity O does light move on a closed circular path?

To determine this distance, the displacement of the light rays by the flow must be taken into account: the waves have to hold up against the flow like a swimmer crossing a river.

(In the following, c is set equal to 1.)



(S5)

v is the flow velocity. c_T is the tangential speed of the light (relative to our coordinate system K) in a point P on the sought orbit. Due to the flow v, c_T is reduced.

According to (9), the absolute value of the flow velocity is

$$|v| = \sqrt{\frac{2m}{r}}$$

According to (6) there is an acceleration

$$\frac{dv}{dt} = -\frac{m}{r^2}$$

In a system *without* flow, at this acceleration the equilibrium condition for a circular orbit is

$$\omega^2 r^3 = m \qquad (\omega \text{ circular frequency})$$

It follows $\quad v_T = \omega r = \sqrt{\frac{m}{r}}$ $\qquad$ (v_T absolute value of the tangential velocity)

Therefore the equilibrium condition is

$$v_T = \sqrt{\frac{m}{r}} = |v| \frac{1}{\sqrt{2}} \qquad \text{(v flow velocity)}$$

So we have to find that r, where the *corrected* speed of light c_T takes on this value of v_T..

It applies $\quad c_T = \sqrt{1 - v^2} = \sqrt{1 - \frac{2m}{r}}$

Taking into account the flow v, the equilibrium condition is therefore

$$c_T = \sqrt{1 - \frac{2m}{r}} = \sqrt{\frac{2m}{r}} \frac{1}{\sqrt{2}}$$

It applies $\quad 1 - \frac{2m}{r} = \frac{m}{r}$

and finally $\quad r = 3m$

We have thus obtained the well-known result.

4.3. Perihelion Precession

The same scheme can be used to calculate the perihelion precession:

We start again from the equilibrium condition for a circular orbit

$$v_T = \sqrt{\frac{m}{r}} \qquad \text{(v_T absolute value of the tangential velocity)}$$

As before, the tangential velocity must be corrected. If v_T is slowed due to the flow by the factor[11]

$$k \quad = \quad \sqrt{1-v^2} \quad = \quad \sqrt{1-\frac{2m}{r}}$$

– then, with respect to the acceleration

$$\frac{dv}{dt} \quad = \quad -\frac{m}{r^2}$$

this corrected v_T is *too slow* for a circular orbit. So we have to go further inwards – i.e. we are looking for that r' where v_T is larger by 1/k, so that the circular orbit condition is satisfied there (in sufficient approximation).

So we set $$\sqrt{\frac{m}{r}}\,\frac{1}{\sqrt{1-\frac{2m}{r}}} \quad = \quad \sqrt{\frac{m}{r'}}$$

Then follows $$\frac{m}{r} \quad = \quad \frac{m}{r'}\,\left(1-\frac{2m}{r}\right)$$

This gives $$r' \quad = \quad r \; - \; 2m.$$

Therefore, the equilibrium condition for the corrected tangential velocity is fulfilled in r – 2m.

Instead of $\omega^2 \; = \; \dfrac{m}{r^3}$ we must therefore set $\omega'^2 \; = \; \dfrac{m}{(r-2m)^3}$

[11] In Section 3.1 we found: *There is only light speed.* Thus, every motion must be thought of as composed of light waves. Therefore, the correction factor always remains the same: *always* light paths are corrected. Any $v < c$ that is not a flow velocity is an interference phenomenon.

$$\omega'^2 \quad = \quad \frac{m}{(r-2m)^3} \quad = \quad \frac{m}{r^3\,(1-\frac{2m}{r})^3}$$

$$\omega'^2 \quad \approx \quad \frac{m}{r^3}\,(1+\frac{2m}{r})^3 \quad = \quad \omega^2\,(1+\frac{2m}{r})^3$$

$$\omega' \quad \approx \quad \omega\,(1+\frac{2m}{r})^{\frac{3}{2}}$$

$$\frac{\omega'}{\omega} \quad = \quad (1+\frac{2m}{r})^{\frac{3}{2}} \quad = \quad 1 \;+\; \frac{3}{2}\frac{2m}{r} \;+\; \frac{3}{8}(\frac{2m}{r})^2 \;+\; .... \quad \approx \quad 1 \;+\; \frac{3m}{r}$$

Thus, the advance per revolution, i.e. the perihelion precession, is $\frac{3m}{r}$, and this is identical with the value resulting from the general theory of relativity.

4.4. The Transition to the Metric View

We continue to look at the spherically symmetric case.

For the calculations carried out so far, we assumed the undistorted, non-relativistic system S_0. It allowed us to directly read the speed of the metric flow and the light waves traveling in it and, based on this, to reconstruct the results of some tests of the general theory of relativity in a metric-dynamic way.

Now, based on the change of the metric density σ, we will determine the metric conditions of a local system *in the flow*, which we call S_F. The entirety of the metric conditions of all local flow systems can be combined to a global system S, which is at rest relative to the center O. (Since both S_F and S are non-relativistic, the differential measures remain unchanged in moving from S_F to S.)

Finally, we will infer from the (local) non-relativistic flow system S_F to the metric conditions of the relativistic flow system S'_F, from which we can transform to the (global) relativistic reference system S', which is at rest with respect to O.

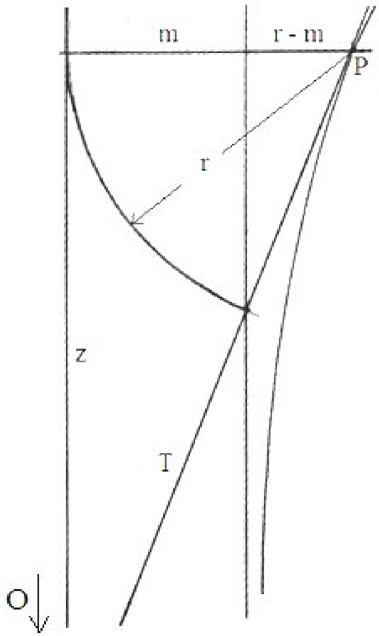
We start with the definition of σ in Chapter 2:

$$dr = dr'\,\sigma \qquad \Leftrightarrow \qquad \sigma = \frac{dr}{dr'} \tag{10}$$

With (5) $\quad \sigma = \dfrac{r - m}{r}$

follows $\quad \dfrac{dr}{dr'} = \dfrac{r - m}{r} \quad$ or $\quad dr' = (1 - \dfrac{m}{r})^{-1}\, dr \qquad (11)$

The following sketch illustrates the metric conditions in S. (Here, dr' corresponds to the radial differential of S and, with this, also to that of S_F .)



(S6)

z is the axis of the auxiliary dimension. P is a point on the curve representing the altered radial measures. dr' corresponds to the length differential on the curve. T is the tangent in P.

As can be seen from the sketch, $(r - m)/r = dr/dr' = \sigma$.

So we know the slope $\frac{dz}{dr}$ at each point. However, integration is not possible – the curve lies "at infinity". But that doesn't matter – the sketch is for illustration only.

The sketch (S6) also shows that to point P the following applies: *before* the metric change, its distance from z is r ($r \geq m$); *after* the metric change, this distance is $r - m$ (expressed by the radial measure dr'). This applies to all Points P, including those arbitrarily close to the intersection of the curve with the r-axis, and therefore

$$r' = r - m$$

So in S every distance from O is smaller by m units than the according distance in S. This means: the metric density σ is defined by the ratio of the distances PO *after* the metric change and *before* it (measured by the units valid in the respective system):

$$\sigma = \frac{r - m}{r} = \frac{r'}{r} \tag{12}$$

From the metric-dynamic point of view, this shortening of the distance from the center O means that the radius of a spherical space is compressed by m units. Therefore, mass – as cause of the metric flow produced in this way – is **defined** as *metric compression* as follows:

An object with the geometric mass m causes a metric compression of the spatial area it occupies. If this area is spherical, its radius – seen from the outside space – appears shortened by m units, i.e. every distance from the center decreases by m.

4.5. The Schwarzschild Metric

Now we make the transition to a relativistic observer system S' that is at rest with respect to O.

Since the flow velocity is known, from a local *relativistic* system S'_F that moves with the flow could be transformed to the system S'. However, this requires the length of the differential dr'_F of S'_F . How can this differential be ascertained?

We have already determined the radial differential dr_F of the *non-relativistic* system S_F :

According to (11) $$dr_F = \left(\frac{r - m}{r}\right)^{-1} dr = \left(\frac{r'}{r}\right)^{-1} dr \qquad (13)$$

As mentioned above, the factor by which dr_F is defined, is the quotient of the radial distance *without* gravitation (= r) and *with* Gravitation (= r – m).

So now we have to ask: How does this factor change in the transition from the non-relativistic flow system S_F to the relativistic flow system S'_F? If the distance of a point P from O with respect to S_F is r – m, what is the distance PO with respect to the relativistic flow system S'_F?

The easiest way to answer this is as follows: According to (9), the speed of the flow is

$$v = -c\sqrt{\frac{2m}{r}}$$

At a distance 2m, the flow reaches light speed. This means: with respect to the flow-system S_F, every finite radial distance becomes 0, so that every point that has a distance 2m from O in the non-relativistic system S, has a distance of 0 in the relativistic system S_F. Thus, for each point at a distance r (r ≥ 2m), the distance from O decreases by 2m. From a relativistic point of view, the continuum is not missing m, but 2m units.[12]

Therefore in the transition from S_F to S'_F, in the factor by which dr' is defined, m must be replaced by 2m. Then this factor again corresponds to the ratio of the distance PO *after* the metric change to that *before* it.

So we get:

$$dr'_F = \left(1 - \frac{2m}{r}\right)^{-1} dr \qquad (14)$$

[12] The Schwarzschild metric, which is our goal, can actually be characterized by the fact that – seen from any local system – the distance to the center is missing 2m units.

However, after the transition to a relativistic view the definition of σ must be left behind. In a relativistic frame of reference, σ is no longer a metric density.

Now for every r with r > 2m the radial differential of the local observer system S', which is at rest relative to O, can be determined.

This is done simply by multiplying the length differential of S'_F by the factor $k = \sqrt{1 - \frac{v^2}{c^2}}$ of the Lorentz transformation.

We know $$v = \pm c \sqrt{\frac{2m}{r}}$$

Therefore $$k = \sqrt{1 - \frac{v^2}{c^2}} = \sqrt{1 - \frac{2m}{r}} \tag{15}$$

For the radial length differential dr' of S' we thus get

$$dr' = dr'_F \, k = dr\,(1 - \frac{2m}{r})^{-1} \; (1 - \frac{2m}{r})^{\frac{1}{2}} = dr\,(1 - \frac{2m}{r})^{-\frac{1}{2}} \tag{16}$$

The time differential dt' of S' can be deduced from the calculations that we have carried out previously in this section. E.g. follows from Section 4.2. Closed Circular Path of Light (see Sketch (S5), that for achieving constant light speed in S', the time interval Δt, which light requires for its way, must be reduced by the factor k. Therefore

$$dt' = dt\,k = dt\,(1 - \frac{2m}{r})^{\frac{1}{2}} \tag{17}$$

The metric of the total system S' corresponds to in the Schwarzschild metric.

Let r and φ be polar coordinates. Then applies:

$$ds^2 = \left(1 - \frac{2m}{r}\right) dt^2 - \left(1 - \frac{2m}{r}\right)^{-1} dr^2 - r^2\, d\varphi^2 \qquad (18)$$

(18) holds for any plane through O.

($r\, d\varphi$ remains the same. The tangential differential has not been changed.)

4.6. The Universal Metric Flow-Field

So far only the scenario with a single central mass has been discussed. I will now briefly sketch the general case.

If the gravitational field is not caused by just one mass, but by many masses distributed in a metric structure (a universe), the following holds:

Any geometric mass m exerts an acceleration on a metric element (a differential) at a distance r that is exactly $c^2 m/r^2$. In contrast to Newton's theory, the gravitational effect propagates at the speed of light.

To find the flow lines – the paths of the metric flow – the points where the total acceleration (the sum of the accelerations from all masses) equals 0 must first be found. If at such a point the outward acceleration in every (possible) direction increases with the distance,[13] then that point is a *source* of the universal flow field.[14]

These sources are the starting points of the flow lines. A subset of the flow lines (possibly) ends in sinks, i.e. in the singularities inside black holes. Another subset continues into the elementary objects that cause the metric flow.

The metric elements moving along the flow lines behave like mass points in the Newtonian gravitational field: the flow velocity at a given point is always the integral over the acceleration along the flow line from the source up to that point.

[13] This additional condition is required because, as we shall see later, there are points with zero total acceleration that are *not* sources.

[14] However, the flow velocity always starts with the value 0 at these points. So there is no real "inflow".

Due to equation (1) [$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}$] and because of the definition σ = dr/dr', to each flow velocity v belongs a specific length differential dr'(v) that is valid *in the flow*. As follows:

From $\sigma = 1 - \frac{m}{r}$ and $\frac{v^2}{c^2} = \frac{2m}{r}$ follows

$$\frac{v}{c} = \pm\sqrt{2}\sqrt{1-\sigma} \tag{19}$$

(σ can take on all real values, v all real and imaginary values.

If σ is 1, then v is 0. If σ is less than 1 (in the case of matter), then v is real. If σ is greater than 1 (in the case of antimatter, see Chapter 5), then v is imaginary. Except for the sign of v, the correspondence is inversely unique.)

With $\sigma = \frac{dr}{dr'}$ follows

$$dr' = dr\,(1 - \frac{1}{2}\frac{v^2}{c^2})^{-1} \tag{20}$$

After the transition to a relativistic representation, *in the flow* applies

$$\boxed{dr_F = dr\,(1 - \frac{v^2}{c^2})^{-1}} \tag{21}$$

and for an observer at rest (who is moving relative to the flow with velocity –v)

$$\boxed{dr_B = dr\,(1 - \frac{v^2}{c^2})^{-1/2}} \tag{22}$$

For the time differential dt_B applies

$$dt_B = dt\,(1 - \frac{v^2}{c^2})^{1/2} \qquad (23)$$

The length differential perpendicular to the flow-direction remains unchanged.

In the spherically symmetric case, these differentials are identical with those of the general theory of relativity. In the general case, however, the metric that results from the metric-dynamic model of gravity differs from that calculated from the general theory of relativity, as will be shown immediately afterwards.

We have determined (19), (21) and (23) from the spherically symmetric case, but it is clear that (19) to (23) hold also in general, not only in the spherically symmetric case, since it is irrelevant whether the acceleration, which a metric element has experienced, comes from a single mass or from many masses.

In this way, if the speed of the flow is known, from the local flow system can be transformed to a local observer system.

This means:

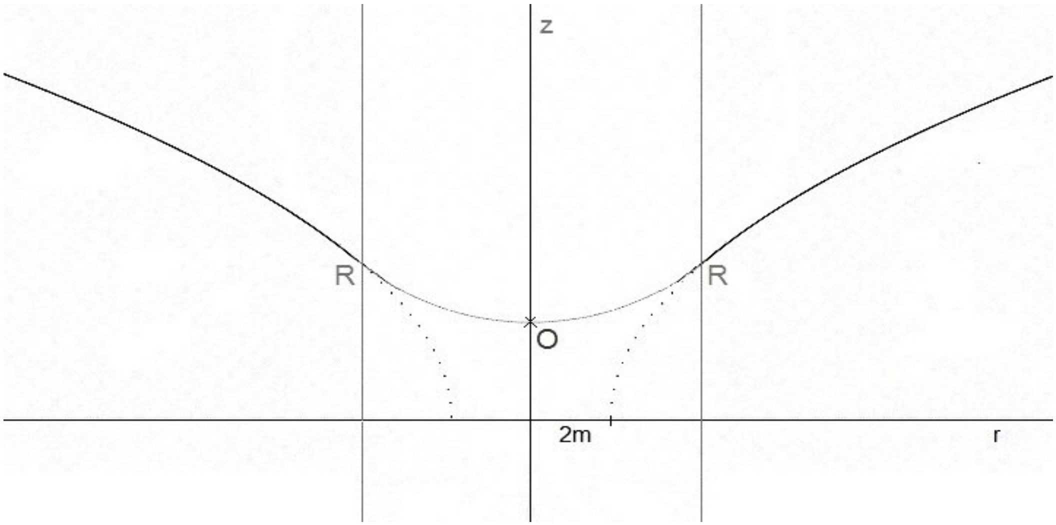
If the magnitude and direction of the metric flow are given at every position in a region of space, then the metric of this region can be determined from the totality of the local observer systems (as we have done previously in the spherically symmetric case).

4.7. Differences between the General Theory of Relativity (GR) and Metric Dynamic Gravitation (MDG)

In the spherically symmetric case of a single non-rotating mass – i.e. in the case of the Schwarzschild solution – GR and MDG correspond to each other.[15] Surprisingly, however, this correspondence exists *only* in this case, and here only with regard to the exterior solution.

We start with the interior solution. Let R be the radius of a (geometric) mass m resting in the origin O. r is the distance from O, z is the axis of the auxiliary dimension.

The sketch (S7) illustrates the metric conditions according to GR:



(S7)

Outside the two points R, the two branches of the Schwarzschild parabola can be seen. Between these two points lies the arc of the interior solution (for constant density).

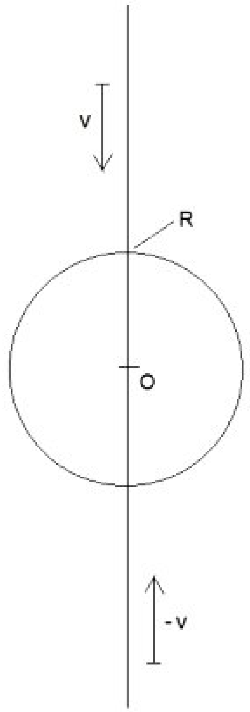
[15] If the mass is rotating, the results of the two theories diverge, as we will show later in the discussion of galaxy rotation.

At point O, the slope of the curve, which represents the changed radial measure, is equal to 0. Therefore in O the radial differential dr_E is equal to the length differential of mass-free space.

In R, at the surface of the mass, the length of the radial differential dr_E reaches its maximum. With decreasing distance to O, this length decreases until it takes on the shortest possible value in O – that of undistorted space.

In contrast, according to MDG the situation is as follows.

We first look at the same mass m from the outside (in normal space):



(S8)

There is a metric flow v(r) – coming from infinity – from above *and* from below.

According to the basic assumption of the MDG, this flow is subject to the acceleration $c^2 m/r^2$. The movement of the metric element (the differential) is therefore identical to the movement of a mass point in Newton's theory. In the outer space – up to point R – this leads, as demonstrated above, to a radial differential dr_B of the local observer system, which corresponds to the differential dr_E calculated from GR.

From R to O, however, the metric flow is further accelerated until it reaches its maximum speed in O. (It moves between the atomic nuclei, like in a gravitational tunnel.) Beyond O its speed decreases until it reaches 0 with $r \to \infty$.

However, as can be seen from (22) $\left[dr_B = dr \left(1 - \frac{v^2}{c^2}\right)^{-1/2} \right]$, the radial differential dr_B becomes longer with increasing flow speed. It follows that this differential reaches its maximum length at O – in contrast to GR, where it is minimal at O and attains its maximum length at R, as we have just established.

The scenario presented in (S8) also demonstrates why it is necessary to distinguish between ***space itself*** and its ***metric structure:***

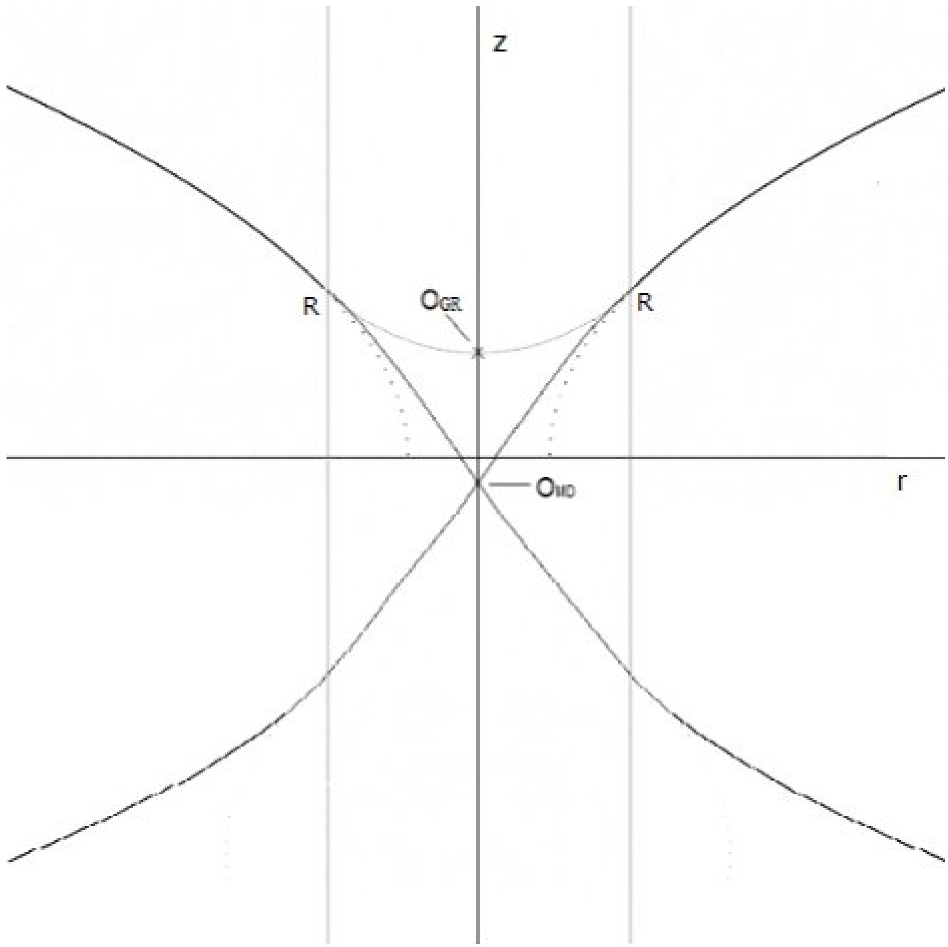
Along the vertical line through O, at every point there are ***two flows***: v(r) and –v(r), which are opposite to each other and have always the same absolute value.

If v were a *flow of space*, then the assertion of two opposite flows at the same point would be nonsensical. But since it is a *flow of the metric*, there is no problem: the only condition is that both flows lead to the same result with respect to the ***metric of the local observer system***. This condition is obviously fulfilled here.[16]

(It is important to keep in mind that the two symmetrical flow systems are *non-relativistic* and therefore unsuitable for the usual kind of transformation.)

The next sketch shows the comparison of the radial metric lengths for GR and MDG:

[16] However, it applies not only here but also in general: If the flow lines meet at any point, then the absolute values of the flow velocities are in any case identical, since the metric elements have always crossed the same potential difference: from the source with the value 0 up to the point of their meeting (see 4.6. The Universal Metric Flow-Field).



(S9)

Above, the curve according to GR as in (S7). It leads through the center O_{GR}.

Outside of the mass, the two curves resulting from MDG are identical to the curve of GR, i.e. to the Schwarzschild parabola. In the interior, however, they deviate from the curve of GR: As the metric flow v increases up to the midpoint O_{MD}, the slope of the curves increases too. Only beyond O_{MD}, the slope decreases again – the radial differential dr_B becomes shorter.

The difference between the slope of the curve in O_{GR} – which is 0 there – and the slope of the two curves in O_{MD} makes it clear how strongly the radial differentials of both theories differ from each other in this point.

Now let us look at the time differential of the interior metric. For constant density there is an exact solution of the field equations of GR: (R radius of the mass, r distance from the center)

$$dt_E\,(r) \;=\; dt\,\left[\,\frac{3}{2}\left(1-\frac{2m}{R}\right)^{\frac{1}{2}}-\frac{1}{2}\left(1-\frac{2m}{R}\frac{r^2}{R^2}\right)^{\frac{1}{2}}\,\right] \tag{24}$$

We will again compare the values resulting from the two theories for the dt valid in O.

First to GR. With r = 0 follows from (24):

$$dt_E\,(O) \;=\; dt\;\left[\,\frac{3}{2}\left(1-\frac{2m}{R}\right)^{\frac{1}{2}}-\frac{1}{2}\right] \tag{25}$$

This time we choose the earth as reference body. I calculated the values for dt approximately. (2m = 8.8 mm, R = 6370 km)

According to GR, for the time differential at the surface dt(R) and for the time differential at the center dt(0) the following applies: (dt is the time differential in mass-free space)

$$dt(R) \;=\; 0{,}99999999931\;dt$$

$$dt(0) \;=\; 0{,}99999999896\;dt$$

In MDG, according to (23), for the time differential applies:

$$dt_B \;=\; dt\;\left(1-\frac{v^2}{c^2}\right)^{\frac{1}{2}}$$

For v I assumed the following values:

v at earth's surface:	v(R)	= 11,1 km/s
v at earth's center:	v(0)	= 19 km/s

The result is:

$dt(R) = 0{,}99999999932\ dt$	(GR:	$dt(R) = 0{,}99999999931\ dt$)
$dt(0) = 0{,}99999999799\ dt$	(GR:	$dt(0) = 0{,}99999999896\ dt$)

As expected, the time differential dt(R) is identical in both theories. At the center, the two time differentials dt(0) differ in the ninth decimal.

The difference in the deceleration of time along the way from the surface of the earth to its center is more obvious. From GR follows

$$dt(R) - dt(0) = 0{,}00000000035\ dt = 35\ 10^{-11}\ dt$$

By contrast, MDG leads to

$$dt(R) - dt(0) = 0{,}00000000133\ dt = 133\ 10^{-11}\ dt$$

So the difference between the time elapsed at the surface and the time elapsed at the center is much larger in MDG than in GR.

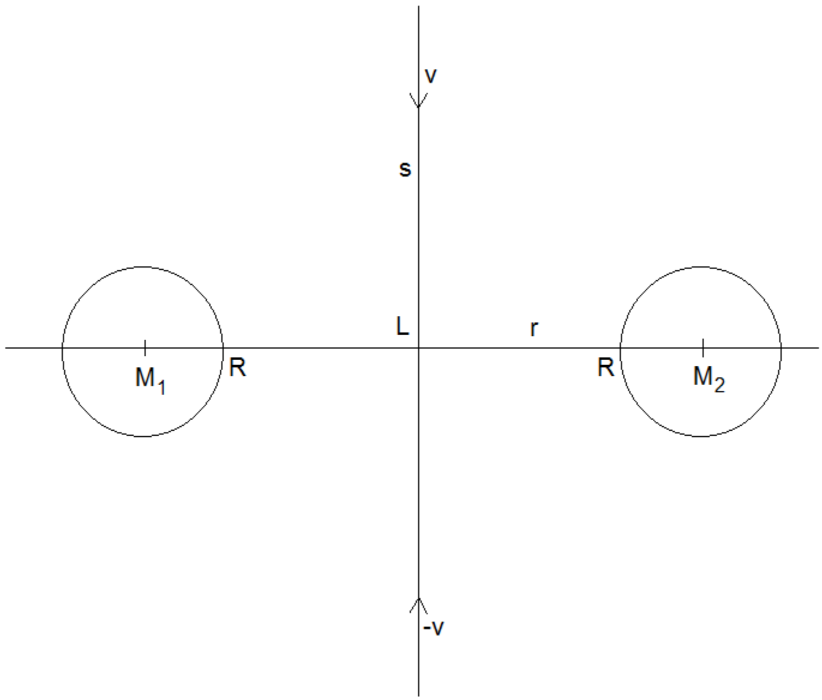
I calculated these values for two reasons: first, to give an idea of their order of magnitude, and second, because the difference between GR and MDG can be verified experimentally. Not in the center of the earth, of course, but somewhere below sea level, which would push the difference further back by a few decimals. However, initial estimates suggest that the remaining difference can be determined experimentally.[17]

So much for the difference between GR and MDG concerning the interior solution of the Schwarzschild metric.

Let us now turn to the differences that arise in the case of multiple masses.

We start with the following example – the simplest case with only two masses:

[17] This experiment would have to be designed like the Mößbauer experiment by Robert Pound and Glen Rebka, except that it must take place below sea level, since it is about the *interior metric* of the earth.



(S10)

M_1 and M_2 are two equal masses. We first consider the metric flow v along the symmetry axis s, which leads through the center of mass L.

The situation is similar to that discussed before: Here too there is a metric flow v, which – coming from infinity – is accelerated up to L, reaches its maximum there and then decreases until it becomes 0 again at infinity, ***and*** an opposite flow –v, for which the same applies. The absolute value of both flows is always identical, so that the calculation of the local metric from both flows always leads to the same result.

The two flow systems correspond to the freely falling systems, with which Einstein demonstrated the generalized equivalence principle, which states that not only uniformly moving systems but also freely falling systems in a gravitational field are (locally) indistinguishable. In GR, this is one of the principles which the mathematical formalism is based on.

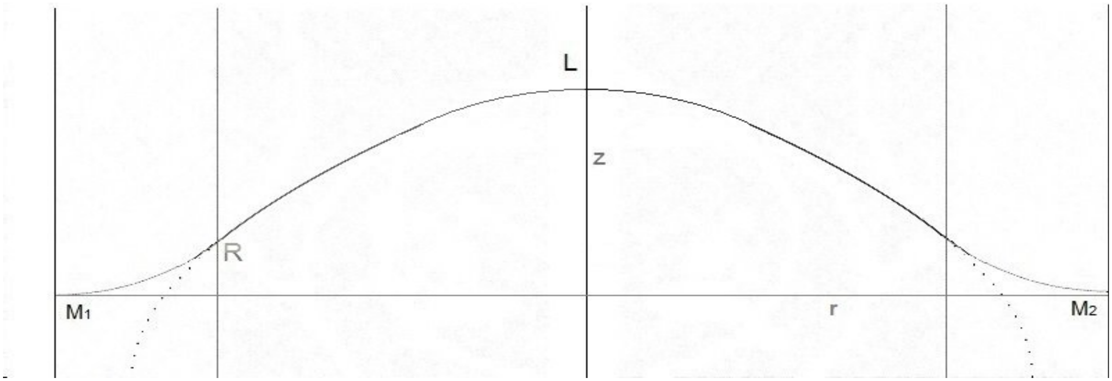
MDG, on the other hand, offers a "direct" explanation for this fact: The freely falling system (from infinity with initial velocity 0) *actually* rests relative to the space that surrounds it, because this space, understood as metric space, flows *itself* with the same velocity – this is indeed how gravity is defined in MDG. Therefore, keeping a body at the same position in a gravitational field means acting against the acceleration of the metric flow.

In other words, *gravity* ***is*** *inertia*.

Despite this conceptual agreement, GR and MDG also differ in scenario (S10). In GR, the length differential ds in L is equal to that of undistorted space, while in MD, according to (22) [$dr_B = dr\,(1 - \frac{v^2}{c^2})^{-1/2}$], it reaches its maximum length in L, since here the flow velocity v has its greatest value.

Now let us turn our attention to the metric flow along the coordinate r.

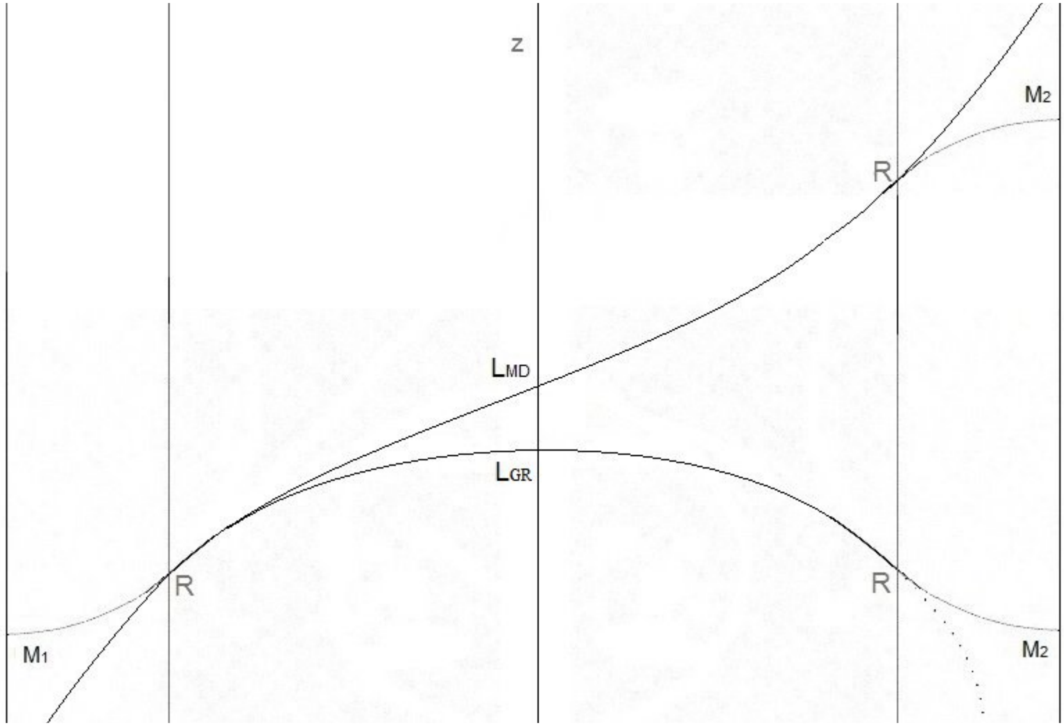
First we look at the metric conditions according to GR represented by an auxiliary dimension z:



(S11)

Beginning on the left, first the curve of the interior space metric, then – starting in R – the Schwarzschild parabola. A symmetrical curve coming from the right. Toward L, the slopes of the two curves must approach the value 0 so that the slope is defined in L. Thus the differential dr in L corresponds to the length differential of undistorted space.

Now again to the comparison of GR and MDG:



(S12)

Beginning bottom left and up to R, the curve first shows the interior metric of MDG, then it corresponds in good approximation to the Schwarzschild parabola. But then the curve of MDG deviates from the curve of GR: although here, too, the slope becomes smaller up to L_{MD}, since the velocity v(r) of the metric flow is decreasing as long as the distance from M_1 is smaller than that from M_2, still the slope can not become 0, since v(r) of course remains always greater than 0.

In order for the slope to remain defined in L_{MD}, one must change to the lower branch of the Schwarzschild parabola of the gravitation field of M_2 when approaching M_2, as shown in the sketch.

This simple example already makes it clear that in the general case GR and MDG differ from each other. However, we will not analyze these differences any further, but turn directly to the question of how they affect the evaluation of the rotation of galaxies.

Remark:

Before we turn to our actual problem, a brief comment on the question of what actually causes the metric-dynamic gravitation.

We have already answered this question formally: the cause is the change in the metric density σ. If this were the only possible answer, then the metric-dynamic theory of gravitation would have the same status as the theories of Newton and Einstein with regard to the question of "why": With Newton it remains open why masses attract each other, with Einstein there is no justification why mass bends space-time. And since in both theories the mass is linked to the respective effect (attraction or space-time curvature) only *by definition* and not through a logical connection, it is impossible in both cases to give a reason for the gravitational effect of the mass.

In contrast, in the metric-dynamic gravitation there is such a logical connection: First of all, it is clear that the increase of the metric density σ in a spatial area leads to a decrease of σ outside of this area. It follows that an object exerts gravity *because* it effects a metric densification of the space it occupies.

Suppose the object is spherical and has the geometric mass m. Then the spherical surface that limits the object has moved inward by m units compared to the situation without the metric densification, and it follows that in the outer space exactly the steady state develops that we derived earlier. A black hole results when this object is compacted to radius 0 – bearing in mind that this is a "metric densification" that applies only with respect to the length measure valid *in* the system. Relative to the outer measure (where σ = 1), the radius of the black hole remains m. (In relativistic view, m becomes 2m.)

Finally, let us ask how such a metric densification could arise. The simplest possibility would be to assume sufficiently large wave amplitudes: they would result in a reduction in wavelength, which would already be equivalent to a metric densification – but only for transverse waves, so that electromagnetism would have to be included. However, I don't think it will be that easy.

Remark:

Claiming an increase in the metric density σ as cause of gravitation seems to contradict the interior metric just discussed: As shown in (S9), the metric density in the interior of the mass is not *greater*, but *lesser* than in the exterior, and toward the center it continues to decrease. This contradiction is resolved as follows:

We have, following tradition, spoken of an "interior metric", but with regard to the objects that *actually* cause gravity – i.e. the atomic nuclei – we are of course still in the *outer space*. However, the actual metric densification can only take place in the interior of those objects from which the gravitational effect emanates. (It may be helpful to imagine the system falling freely from infinity on its way through the Earth's interior in a gravitational tunnel, i.e. in a cylindrical well through the center of the Earth.)

In the MD, the designations "constant density" and "interior metric" are therefore misleading.

4.8. The Rotation Speed of Galaxies

First, a very brief summary of the facts:

In the inner regions of galaxies, the observed velocities of the stars agree with those to be expected according to Newton or Einstein. In the outer areas, however, the speeds do not decrease as in solar systems, but remain approximately the same.

There are only two possible explanations for this: a) There are invisible masses, b) Our theories of gravity are wrong.

To a) For more than 40 years attempts have been made to find out what this "dark matter" could be. The standard model of particle physics was examined for possible candidates – without sufficient success. Even the plentiful supply of speculative particles of supersymmetry has yielded no results at the Large Hadron Collider and elsewhere. This is of course an advantage for the models and simulations based on dark matter: all parameters can still be freely used. But actually the situation is rather depressing.

To b) Since the rotational speed, as mentioned, agrees with Newton's theory or GR up to a certain distance from the center and only deviates from it further out, there is the possibility of modifying Newton's and Einstein's law in such a way that this modification has a significant effect only at a greater distance, i.e. in the area of very weak gravitation.

In Newton's equation, the force then no longer falls quadratically with the distance but only linearly, and in Einstein's equation, the same effect is achieved by several tensors – using the mathematical freedom that already enabled Einstein to add his "cosmological constant".

While it is admittedly legitimate to adjust a law with minimal effort in order to adapt it to observations, it is still an *ad hoc* action that remains questionable until it can be justified by general principles.

The most important scenarios in the universe are these two: solar systems and galaxies. The theories we use to describe them are valid in solar systems, but in galaxies they are not even approximations, they are just grossly wrong – unless we assume the existence of dark matter. So it seems we are faced with an unattractive alternative; To a certain extent we are in a lose-lose situation – but only as long as we judge the problem according to our usual understanding of gravity: from the point of view of MDG, the situation is quite different. Here, based on a few simple considerations it seems compelling that a significantly higher rotation speed is to be expected than according to Newton's or Einstein's theory:

In the MDG, the metric elements are accelerated toward the masses – one could say: *they follow the masses*. So it is actually self-evident that in the case of galaxies, where the majority of the total mass rotates, also a rotation of the metric develops. As we have shown, however, it is also true that *the masses follow the metric*. And this means that the rotation speed of the masses is increased by the rotation of the metric.

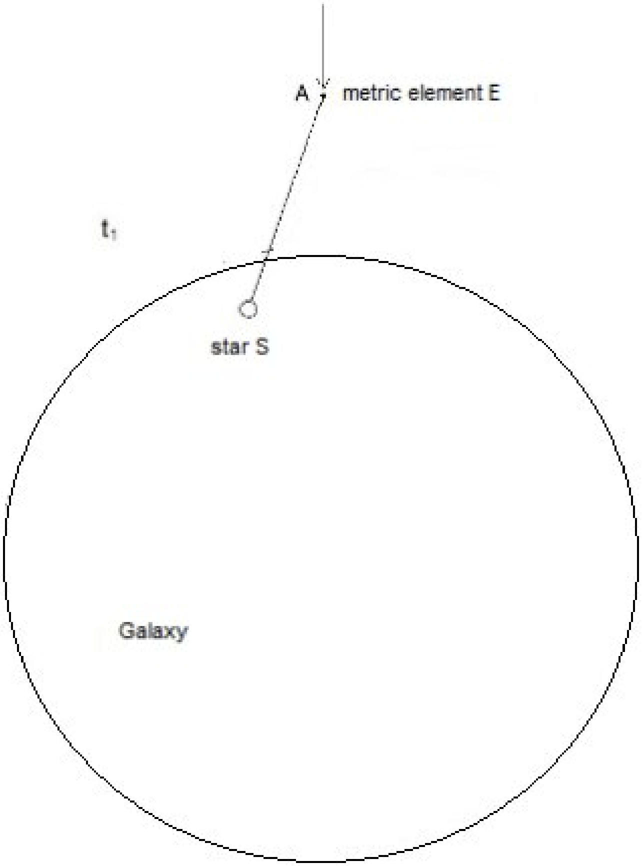
I will therefore carry out the argument in two steps: First I will show in more detail that from the assumptions which MDG is based on it must be concluded that in galaxies the metric – or, for the sake of simplicity, let's say: *space itself* rotates, and then I will argue that this rotation of space must be added to the rotation speed of the stars that follows from Newton's or Einstein's theory.

We look at a galaxy from a point on the axis of rotation:

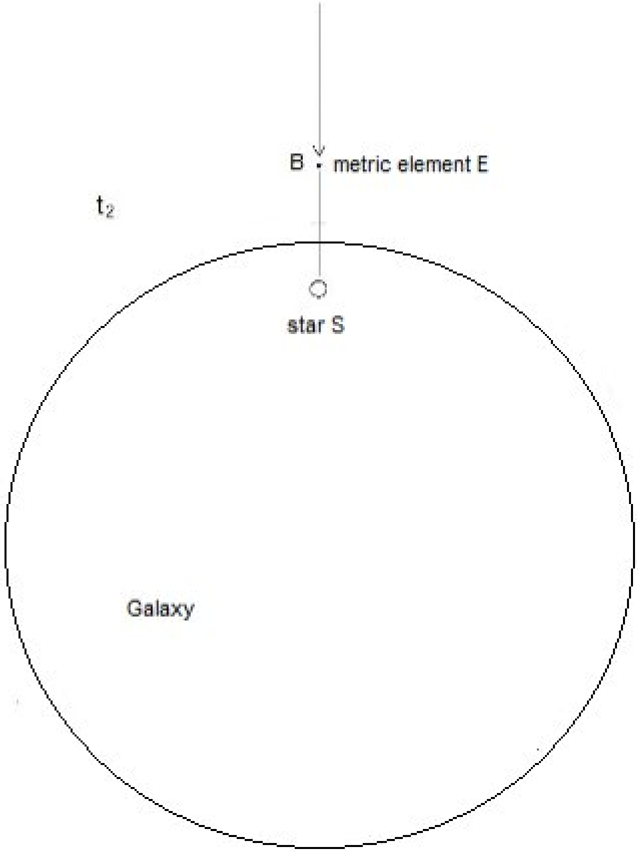
(S13): At time t_1 there is a metric element E at point A, which – falling freely from infinity – is accelerated in the plane of rotation toward the galaxy. (The finite propagation speed of gravity is irrelevant for the following reasoning, so we can ignore it.) Also shown is S, one of the galaxy's stars.

(S14): At time t_2, the metric element E has reached point B. The star S is now exactly on the line through B and the galactic center.

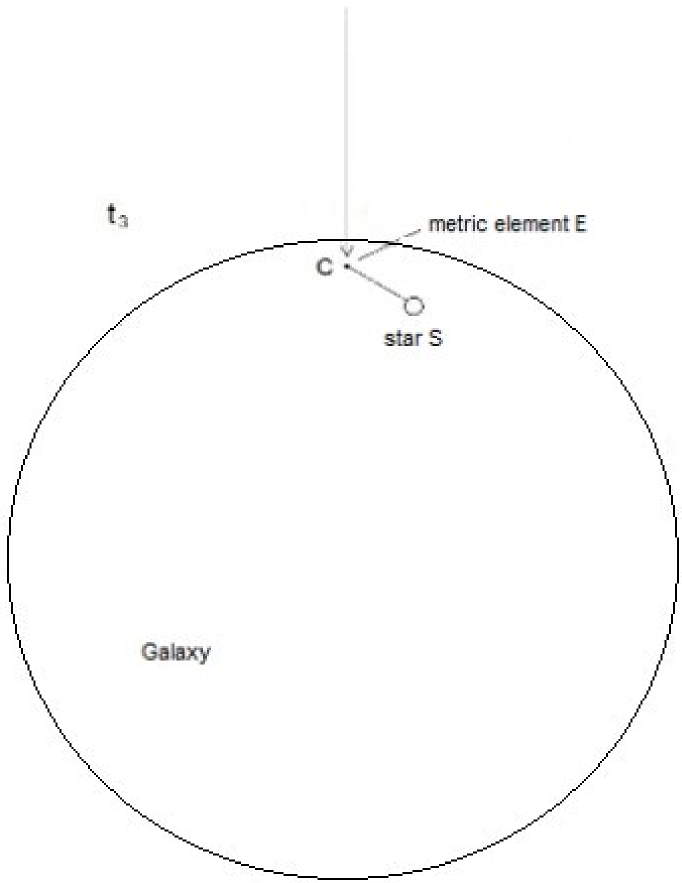
(S15): At time t_3, E has advanced to point C. ($t_2 - t_1 = t_3 - t_2$)


A
metric element E
t1
star S
Galaxy

(S13)

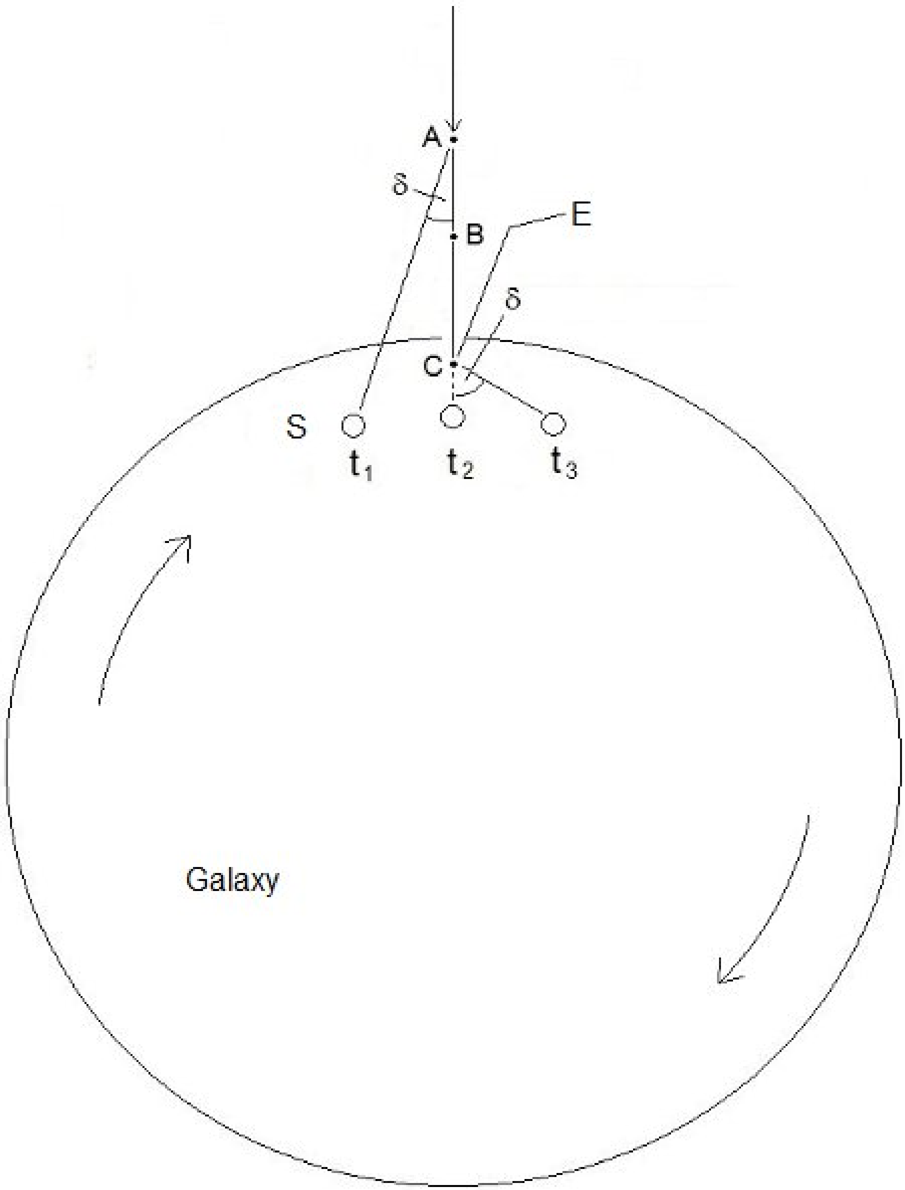

B
metric element E
t2
star S
Galaxy

(S14)



(S15)

(S16) shows the situation at all three points in time:



(S16)

Coming from above (starting at infinity with speed 0), there is a metric flow v(r), where r denotes the distance from the center of the galaxy. In the sketch, this flow is represented by the movement of the metric element E.

Let m be the geometric mass of the star S, d be the (time-dependent) distance between S and E.

Then, according to the basic assumption of MDG, S exerts an acceleration $c^2 m/d^2$ on E.

The movement of the metric element E is thus identical to the movement of a mass point in Newton's theory (apart from the fact that in MDG gravity propagates with the speed of light). We split this acceleration b into a radial component b_r and a tangential component b_t. It applies

$$b_r = c^2 m/d^2 \cos\delta$$

$$b_t = c^2 m/d^2 \sin\delta$$

As can be seen from the sketch (S16), it follows that E experiences a tangential acceleration to the left side (opposite to the direction of rotation) between t_1 and t_2, and to the right side (in the direction of rotation) between t_2 and t_3.

The central point of our argument is that at any point in time between t_2 and t_3 the magnitude of b_t is much larger than between t_1 and t_2, so that the velocity of E – i.e. the velocity of the metric flow – at point C has a tangential component pointing to the right.

There are two reasons for this:

1.) In the time interval between t_1 and t_2, the distance d between S and E is greater than between t_2 and t_3 – in our case about twice as large on average.

(Since the star S is far out in the galaxy, the speed at which it rotates is approximately $c\sqrt{\frac{m_G}{r}}$ (m_G is the geometric mass of the galaxy). The absolute value of the velocity of E is equal to that of the escape velocity, i.e. it is equal to $c\sqrt{\frac{2m_G}{r}}$. However, E is further out. Overall, the result is that E travels about the same distance as S between t_1 and t_3.)

Thus, at any point in time between t_2 and t_3, the acceleration that S exerts on E is on average four times greater than between t_1 and t_2.

2.) Moreover, the angle δ which the component b_t depends on is significantly larger between B and C than between A and B – especially if one takes into account the initial displacement of E to the left. From this follows that with regard to the tangential component of the acceleration b_t, there is a further increase, in addition to the factor 4 of the total acceleration.

So it can be claimed:

Due to the acceleration that S exerts on E, the velocity of E at point C has a non-negligible tangential component in the direction of rotation.

This result can be generalized as follows:

The reasoning that we just carried out for the star S applies to any star that crosses the line through E and the center of the galaxy and is closer to the center than E at the time of crossing.

However, for stars that are further away from the center than E at the time of crossing, the above conclusion gets reversed, since E is then closer to the star in the time interval *before* the crossing than in the time interval *after* the crossing, so that the acceleration, which E experiences, is greater in the direction *against* the rotation than *with* it.

From this follows: the further E penetrates into the galaxy, the smaller becomes the tangential component of the velocity of E. However, since the average stellar density increases inwards, it can be expected that the space rotation is maintained over a wide range and disappears only near the center.

Stars that are at a greater distance from the line through E and the center, do not have to be taken into account because they average out. (For every star that is on the left side of this line there is a star on the right side, so that the tangential component of the acceleration of E vanishes on average.)

We have thus arrived at the following statement about the metric flow:

If a galaxy rotates, then the metric flow rotates too, i.e. its velocity has a tangential component in the direction of rotation. This "rotation of space" begins already far outside of the galaxy, increases with decreasing distance and reaches its maximum at the outer edge. Toward the center it decreases again.

So much for the first step of our argument. Now to the second step, to the question:

How does the rotation of space affect the rotation speed of the stars?

Let us first assess the situation as seen from Newton's theory. Since space here merely represents the stage on which physical events take place, it initially seems strange to speak of a "movement of space". On the other hand, however, it is self-evident that, when determining the rotation speed, one must refer to a "resting space"; so it is necessary that a system with speed 0 exists, and this is of course the system resting relative to the center of the galaxy.

In the MDG, however, the system that is to be understood as "system at rest" in relation to the rotation is *that* system that moves with the tangential component of the velocity of the metric flow. For the calculation of the velocity of the stars, this is the system with the velocity 0. Thus, the rotation velocity calculated according to Newton refers to this system. This means:

The speed at which space rotates at the distance r must be added to the speed at which a star moves at the same distance.

What has just been said about the effect of space rotation on the calculation of Newton's rotation speed remains valid with respect to GR. For assessing how the rotation of space affects the calculation of the speed of the stars, the following facts are decisive:

The world lines of the stars rotating around the center of the galaxy are timelike geodesics. The distance between two points on their path, measured by proper time, thus assumes an extreme value. The time differential on this orbit depends on two factors: on the field strength and on the speed of the star. However, this speed must – as with Newton – refer to a system at rest, where "at rest" can only have the meaning: at rest "relative to non-rotating space". In this system, the time lapse becomes maximum.

In MDG, on the other hand, time elapses fastest in a system that is at rest "relative to rotating space", and it follows that the calculation according to GR must refer to *that space*, i.e. to the rotating space. Thus in GR, just as with Newton, the speed of the space rotation has to be added to the calculated speed of the stars.

Even if the above argumentation is only qualitative and at best allows a rough estimate, it can be concluded that according to the MDG a significantly higher rotation speed of galaxies is to be expected than according to Newton's or Einstein's theory. In addition, it also contains an indication that the MDG has the same effect as the *ad hoc* terms inserted in Newton's and Einstein's theory:

the changes mainly affect the outer regions of galaxies, while the inner regions remain almost unchanged.

In trying to calculate the rotation speed of the metric space, one is confronted with the following difficulty:

The speed of the stars and the speed of the space rotation affect each other. A feedback loop is created: the faster the stars move, the faster space rotates, and vice versa. This mutual acceleration continues until equilibrium is reached – a process that occurs as the galaxy evolves.

However, there is a relatively simple way to deal with this difficulty: one does not start by calculating the rotation of space, but by observing the stellar velocities and estimating the total mass of the galaxy. (Without dark matter.) The difference between the observed velocities and the velocities calculated from the mass of the galaxy – according to Newton or Einstein – then gives the speed of the space rotation.

In this way it can be checked whether this difference is explained by the MD: if the velocities of the stars are known, the rotation of the metric can be calculated or determined by a simulation and compared with this difference.

Remark:

Because galaxies are systems whose total mass is distributed among numerous objects, the results of Section 4.7 (on interior metric and multi-mass systems) must apply to galaxies to some extent. This means that even within galaxies, the radial differentials determined from MDG are greater than those calculated from GR, and the time differentials are smaller. However, since these differences are negligible in the outer region of a galaxy and only gradually increase as we approach the center, and because the rotation speed is too high only at a greater distance from the center, they can be neglected in the approximate determination of the galaxy's rotation.

4.9. Other Effects

In addition to galaxy rotation, there are other effects – e.g. gravitational lensing – which, from the point of view of Newton's or Einstein's theory of gravity, indicate stronger gravity than would be expected from the visible matter. These effects can be explained by MDG in the following way:

In GR, the passage of time is slowed down by the gravitational field: the stronger the retardation of time, the stronger the gravitation. In MDG, time slows down due to the metric flow: the greater the flow, the greater the retardation of time.

If the metric flow is directed exactly toward the gravitational mass – as in the spherically symmetric case of a single mass – then, in the outer space, the time measures of the local systems determined from GR agree with those calculated from MDG. In all other cases, GR and MDG differ from each other, as we showed in Section 4.7.

The reflections on galaxy rotation have led us to the conclusion that in galaxies the velocity of the metric flow has a tangential component. While the radial component directed toward the center of mass results in a time differential that largely corresponds to that of GR (at least in the outer regions of the galaxy), from the tangential component – i.e. from the space rotation – follows an additional retardation of time.

Since this rotation of space does not exist in GR, the resulting time retardation must be understood – from the GR point of view – as the effect of a stronger gravitational field, in other words: as additional gravity, which forces the assumption of additional (invisible) matter.

From the point of view of MDG, the principle that objects move in the gravitational field on time-like geodesics remains valid, but for calculating their orbits the time differentials must be used that have changed compared to GR. So the gravitational effect stays the same, it is just interpreted differently: What in the GR can only be understood as consequence of additional, invisible mass appears in MDG as consequence of the rotational speed of the metric flow. The assumption of invisible mass is superfluous.

Note:

In principle, the argumentation on galaxy rotation applies in every case in which masses rotate around the center of mass, i.e. also in the case of planets with self-rotation. I recently stumbled upon the formula used by J.D. Anderson and others to describe the so-called Flyby Anomaly. In this formula, the very small increase in speed experienced by space probes during fly-by at Earth, which has not yet been adequately justified, is linked to the Earth's rotation.

Anderson's formula is heuristic, i.e. it represents an attempt to construct a law that corresponds to the available data in the simplest possible way. Perhaps the MDG can provide the explanation for this. But I didn't investigate it further.

4.10. Summary

In Newton's and Einstein's theories of gravity, there are three basic physical concepts: space, time and mass (measured in kilograms). With Newton, mass acts directly on mass, instantaneously and mediated by nothing. With Einstein, mass acts on space-time, which in turn acts on mass.

In metric-dynamic gravitation there is only space and time. Mass is defined as metric densification of an area of space in the following way:

Suppose an object is spherical and has the geometric mass m ($m = MG/c^2$). Then the sphere that circumscribes the object has moved m units inwards, compared to the state without mass. The area of space occupied by the object experiences a *metric densification* through the mass: if the radius of the spherical surface is R *without* mass, then *with* mass m it is only R – m.

This means that – from the point of view of an observer who is located at any point in the space outside of the object – the distance to the center of the spatial area has decreased by m. Thus it follows for the metric density σ at a distance r:

$$\sigma(r) = (r - m)/r$$

(In the respective units.)

As a result, based on equation (1)

$$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}$$

in the outer space, a *metric flow* v(r) is caused that is directed toward the mass.

Now the acceleration exerted by the mass on the elements of the metric flow (the length differentials along the flow lines) can be derived directly: it is c^2m/r^2, i.e. it corresponds to the Newtonian gravitational acceleration. However, in MDG the gravitational effect does not occur instantaneously, but is transmitted with the speed of light.

MDG arose from the assumption that reality is a fabric of interdependent metric changes in space and time. The metric flows of gravity are a special form of this interaction of space and time changes. From this follows that everything that exists participates in the acceleration of the metric flow. Therefore, this acceleration can be interpreted as gravitational acceleration.

However, determining this acceleration and the resulting size of the metric flow v(r) is only the first step. In connection with the definition of the metric density σ (σ = dr/dr'), the space and time measures valid in the flow can be calculated, from which in turn follows the metric of the local system at rest (which moves relative to the flow with −v).

In the outer space of a single, non-rotating mass, the results of MDG agree exactly with the results of GR. On earth and in the solar system, these two conditions are fulfilled in sufficient approximation.

Thus in the two scenarios where the most accurate tests of the theories of gravity take place, there is no measurable difference between GR and MDG – apart from a few exceptions where extremely small deviations occur.

In all other scenarios, however, the two theories lead to different results. In order to be able to estimate these differences with regard to different physical systems, these systems must be assessed according to 3 criteria:

1.) mass distribution

2.) total torque

3.) total mass

To 1.) The two extremes of mass distribution are *concentration* and *equal distribution*.

Solar systems and galaxies lie near the two extremes: in our solar system, the mass of the sun is more than 700 times the mass of all planets; In contrast, the total mass of the stars in our galaxy is more than 30,000 times greater than the mass of the central black hole.

In the case of a dominant mass – which then forms the center of the system – GR and MDG lead to the same results. This was demonstrated in Sections 4.1 to 4.5.

However, as we proved in Section 4.7, this only applies to the exterior space. In the inner space, the two theories differ from each other, with the differences increasing toward the center.

At the same time, the interior represents also the model for the other extreme of mass distribution, i.e. for equal distribution. A solid body – such as the earth – is actually an aggregate of (approximately) evenly distributed masses. Therefore, the results of the interior metric can be transferred to all systems in which the masses are (approximately) equally distributed, e.g. also to galaxies.

This means:

In systems where the masses are not concentrated in the center but rather evenly distributed, the time of MDG is identical to the time of GR only at the outer limit, but near the center it is slowed down much more than in GR. (In the interior metric, in MDG the deceleration is almost four times greater than in GR, see Section 4.7, page 56.)

The radial differentials are identical only on the outside, but toward the center they become longer in the MDG and shorter in the GR. Only the tangential differentials are identical in both theories. (However, these statements only apply in relation to the dependence on the mass distribution. The consequences of the rotation must then also be taken into account.)

To 2.) If the system rotates around its center, the space or the metric rotates as well, as we showed in Section 4.8. The metric flow then has a tangential component, in addition to the radial component directed toward the center.

This means:

Due to the tangential velocity of the metric flow, time is slowed down in a frame of reference that is resting (non-rotating) relative to the center. In this reference system, compared to GR the tangential length differentials are shortened.

Seen from GR, these changes appear like increased gravity, which can only be understood as a consequence of additional mass.

From the point of view of MDG, one has two options: For estimating the rotation speed, one can simply add the rotation of the metric to the rotation that follows from Newton's or Einstein's theories. If one wants to determine the effects of the stronger gravity in general, which results from MDG compared to GR, the geometric methods of GR can still be used, but the changes of the metric must be taken into account.[18]

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[18] However, initially only the values of the differentials parallel and normal to the respective flow direction are directly accessible, see Section 4.6, Equation (22). The length differential perpendicular to the direction

To 3.) The extent of the deviation of GR and MDG depends (of course) on the total mass of the considered system.

In this way, the simple argumentations and deductions of Sections 4, 5, and 6 allow us in many cases to estimate to what extent GR and MDG differ from each other. The result of this estimation can then be compared with observation.

For the assessment of galaxy rotation, point 2 is decisive:

According to our argumentation in Section 4.8, a rotation of the metric evolves, which is of the magnitude of the rotation of the galaxy that is to be expected according to GR, and which must be added to this rotation. It also follows from this reasoning that the rotation of the metric extends far out into the space surrounding the galaxy, reaches its maximum at the outer edge and decreases toward the center.

The magnitude of the metric rotation depends on the total torque of the galaxy. It is therefore to be expected that, in some cases, elliptical galaxies will have a much lower rotation speed.

Although also point 1 plays a role according to the above explanations, because – just as in the metric of the inner space – the radial length differentials determined from GR and MDG as well as the time differentials are approximately the same only in the outer region of the galaxy and differ more and more toward the center, it can nonetheless be assumed that these differences can be neglected as regards the rotation speed. The reason for this is simply that the observed velocity deviates from our expectation only in the outer regions, i.e. where the differences between GR and MDG that stem from the mass distribution are already small.

If the galaxy has no total torque at all, then it can even be assumed that – with respect to the outer space of the galaxy – GR and MDG agree completely, because then this case again corresponds to the case of the outer space of a non-rotating solid body.

In summary, for the galaxy rotation the following results:

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of the flow remains unchanged, i.e. it corresponds to that of undistorted space. (23) gives the time differential.

Contrary to the theories that emerge from Newton's or Einstein's theory through *ad hoc* modifications, the MDG leads *by itself* to a greater rotation speed due to the concept of the *metric flow.*

In my view, this is a strong reason for pursuing this concept further.

It is astonishing that there exists a theory, which perfectly reproduces the verified results of GR in important areas (Earth, solar systems), and yet in other scenarios deviates widely from GR, most notably in galaxies which – because of their great distances – we have only been able to observe with sufficient accuracy for a much shorter time.

Moreover, this deviation seems to be exactly of the form that observation dictates. And that is all the more astonishing since this deviation does not occur as a function of distance – as it initially seems obvious – but results from the structure of MDG, as a consequence of the metric flow, which does not exist in GR.

4.11. Assessment

In this paper I have tried to show how the metric-dynamic view of reality changes our understanding of gravity. So far, my remarks have essentially related to the problem of galaxy rotation. In order to be able to assess the MDG correctly, however, it is now necessary to remove this thematic restriction.

As is well known, there is a problem that does not affect the theory of gravitation itself, but its position in the overall structure of physics: the contrast or rather the incompatibility of the theories of gravitation and electromagnetism. It seems as if this contradiction could be completely eliminated by MDG. As follows:

The GR is a metric theory. It claims the metric of space-time *exclusively* for itself: space-time *is* gravity. There is no place in it for anything else. From that an irremediable structural difference between gravitation and electromagnetism follows: G *is* metric, EM *cannot be* metric – it acts *in* space-time, but not *through* space-time; as with Newton, here space is actually only the stage for the physical events.

In MDG, this is completely different: Although it is also a metric theory, in contrast to GR it is based *exclusively* on changes of the *length measure*. Changes in the angular measure remain unaffected.

I already stated in Chapter 2 that the metric density σ in equations (0) and (1), which represent the generation of reality, has two possible interpretations: σ can be the metric density of length or the metric density of angle – or let us rather say: σ *must* be both, otherwise the description of the origin of reality would be incomplete, since space can change in both ways.

This means that now there is room in space-time for other interactions. And indeed the interpretation of σ as metric density of the angle leads to electromagnetism – in a way almost entirely analogous to, and just as simple as, the way gravity was presented here.

Thus the fundamental difference between G and EM is eliminated and at the same time their connection is clarified: both are metric phenomena that follow from equations (0) and (1) and the simplest associated metric assumption.

Much more could be said about this. But I will end my remarks here. For an adequate assessment of the metric-dynamic description of reality, it seemed necessary to me to point out the connection between gravitation and electromagnetism that results from it, but in the context of my brief explanations about gravitation I will limit myself to these few comments.

The metric-dynamic gravitation arose from metaphysical considerations. Therefore, this work started with metaphysics. It will now also end with metaphysics, because the most important argument for MDG – which, in my view, excludes any other kind of theory of gravity – is also of a metaphysical nature. As follows:

Space and time – or alternatively: space and motion – are *necessary* as basis for a description of reality, because without them there would be Nothing. We cannot think the changing space, but we can make it available for our thinking through the concept of metric. The first law, described by equation (0), is also necessary because without it there would again be Nothing.

But if we now add a further element, which is *independent* of space and time, then we have not only left the realm of necessity, but we have also postulated something impossible: indeed this additional element must be causally connected to space and time, and that would only be possible if it could be *defined* by space and time.

If this is not the case, then the new element has no logical connection to the scenario that we have determined as starting point for the description of reality.

In physical terms, this means the following:

There can only be two basic units: the unit of length and the unit of time. Every other unit must be derived from it. (See also here and here.)

In the case of gravitation, this concerns the unit of mass: there can be no mass whose unit kilogram is an independent basic unit. Such a mass *cannot* affect space and time. It is logically and ontologically separate from space and time, and this means that a causal connection between this mass and space and time is impossible.

Mass must therefore be definable through space and time. It must be a *state* of space-time. Only then can it affect space-time and in this way influence other masses.

Therefore, gravitation must be of a metric-dynamic nature. Any other kind of gravitation is impossible.

However, from this does not follow that the theory of gravitation presented here is correct – I consider the metaphysical argument to be much stronger than some of my derivations. But it follows that Newton's and Einstein's theories of gravitation can only be approximations.

Postscript

For more than a hundred years, the general theory of relativity has determined our understanding of gravity. This is also shown by the fact that in the case of discrepancies – as with the problem of galaxy rotation – the main focus is on extensions and additions to Einstein's field equations, while the theoretical basis is hardly called into question.

However, the metric-dynamic theory of gravitation cannot be interpreted in this sense – it differs too much from GR. So, on the part of the MDG, one is faced with the question of whether there are any errors in Einstein's assumptions and conclusions, which form the basis of the theoretical edifice of the GR.

From the metric-dynamic approach to physics, the answer is as follows:

The first error occurs right at the beginning of Einstein's considerations: he assumes that *all* changes in lengths and times can be related to gravitation. One of the examples he uses to explain his approach is the rotating reference system, whose metric changes – derived from the special theory of relativity – are interpreted by a co-rotating observer as the effects of a gravitational field; indeed the general principle of relativity states that all observers are entitled to consider themselves to be at rest – they only have to relate the accelerations which they experience to a (hypothetical) gravitational field.

From the point of view of the MDG, however, this is inadmissible, since most of these hypothetical gravitational fields are not compatible with the definition of the metric flow and the resulting gravitational acceleration.

Already from this simple statement follows that GR also contains cases that are "unphysical"; the definition of the metric flow imposes far more severe constraints on the allowable gravitational fields than Einstein's derivation of the field equations of the GR.

In addition, seen from the MDG, Einstein's assumption that all space-time changes are to be interpreted gravitationally is also inadmissible because, as mentioned above, in the metric-dynamic approach part of these changes must be attributed to electromagnetism. However, with the assumption he initially made, Einstein banned all other physical processes from the area of spatiotemporal changes right from the begin of his derivations.

(As is well known, Einstein tried to remedy this deficiency by generalizing the GR already in the years after 1915 and up to the end of his life. Schrödinger, Weyl and others were also involved in this project. However, their decades-long effort did not lead to any physically usable results.)

So this is one side of the error: GR is "too general": it contains cases that do not belong to gravity, and also cases that are physically impossible.

The other side of the error is exactly the one revealed by the wrong result in the calculation of the galaxy rotation (assuming no dark matter exists):

There are cases that are *not* included in GR and therefore cannot be explained from it. As shown in sections 4.7 and 4.8 of this chapter, this applies indeed to *all* cases except one: the case of a single, non-rotating mass.

From the point of view of the MDG, the reason for this deficiency is that the central concept of MDG – the metric flow – cannot be integrated into the model of gravitation along the way that Einstein has chosen.

In the same way as Newton's theory – seen from the GR – can only be regarded as an approximation for the case of low gravitation, from the metric-dynamic point of view both Newton's theory and the GR are to be regarded as approximations that are only applicable, if the rotation of space is negligibly small. Otherwise they lead to grossly incorrect results.

There is an important difference between the view of gravitation I have presented here and the modifications of Newton's and Einstein's theories of gravitation that have been proposed so far:

Since GR has proven itself so well in the gravitational field of the earth and in the solar system, the authors of the adapted versions assume that GR is correct in principle and needs to be changed only in the area of very weak gravitation. The corrections are then motivated solely by the intention of adapting the theory to the conditions in galaxies – in other words: they are completely *ad hoc*.

In the case of MDG, the situation is quite different: the MDG follows from considerations about the origin of reality and from the continuation of Einstein's analysis of the time relations. The resulting change in the view of gravity is not related to the weak gravity regime, but depends on the total torque and mass distribution of the system under consideration. So the MDG is not designed in regard to the observed anomaly – the higher rotation speed is simply a result of the structure of the theory.

There is no doubt that this type of connection between theory and desired result is far preferable to *ad hoc* constructions.

I would like to end this postscript with a personal remark: After I had discovered my theory of gravitation, I carried out several tests, some of which are also listed in Sections 4.1 to 4.5 of this chapter When my theory passed these tests (by agreeing with GR!) – and, at that, in such a strange, almost ridiculously simple way – I was initially convinced that I had just found a different, much simpler approach to GR. It wasn't until years later, when I was thinking about galaxy rotation, that I began to realize that MDG differs from GR.

However, the magnitude of the difference between GR and MDG has only become clear to me in the past three months that I have spent writing this chapter. At first this insight irritated me; For me, as for many others, GR has been one of the greatest achievements – if not *the* greatest achievement – of the human mind, a temple that rivals any other building.

In the last three months, however, I have learned to understand my own theory better and, as a result, to trust it more. By now it seems likely to me that the GR is built on a flawed foundation. A significant part of its complexity would therefore be superfluous or even misleading ballast.

In this picture, the MDG would appear as (re)discovered simplicity – after a wrong path that lasted for more than a hundred years.

But actually all these considerations are obsolete. Ultimately, only observation and experiment can decide between competing theories of gravitation or the alternative assumption of dark matter.

Addendum: The Hybrid System

At the transition from Newton's approximation of gravitation to the relativistic description (see 4.4. and 4.5.) it was necessary to correct the factor, by which the metric is defined, from (1 – m/r) to (1 – 2m/r).

However what would be the case, if the special relativity theory was part of physics, but the transition from Newton's gravity to the general relativity theory would *not* have taken place?

Then the non-relativistic point of view would have to be maintained – exactly how it was presented in Section 4.4 – and the metric factor would remain (1 – m/r).

If the metric flow was factored in *under this condition*, then to its speed would apply (compare (9))

$$\boxed{v = -\sqrt{\frac{m}{r}}} \qquad (9h)$$

– because only then the flow velocity would be equal to the light speed at r = m, so that the distance of this point from O would be zero, as required by the metric *before* the transition to the relativistic view.

Formally, this result is achieved if, on the one hand, the equation is applied that is valid in the relativistic view (see (21), c is set to 1):

$$dr' = dr\,(1 - v^2)^{-1} \qquad \text{or} \qquad dr/dr' = (1 - v^2)$$

and, on the other hand, the definition of σ is maintained: $\sigma = \dfrac{dr}{dr'}$. With $\sigma = 1 - \dfrac{m}{r}$

then follows $1 - \dfrac{m}{r} = 1 - v^2$ and therefore $v = \pm\sqrt{\dfrac{m}{r}}$.

As a consequence, the relativistic local flow system S_F changes to S_F' (compare with (14) and (11)):

$$S_F: \quad dr_F = (1 - \frac{2m}{r})^{-1} \, dr \qquad \longrightarrow$$

$$S_F': \quad dr_{F'} = (1 - \frac{m}{r})^{-1} \, dr \qquad \text{(11h)}$$

Why this hypothetical variant?

Because in the following it will actually be necessary to apply the value from (9h) to the flow velocity.

The reason is that, in current physics, all interactions except gravity occur within the flat spacetime. From the metric-dynamic point of view, however, this is exactly the state in which gravity has been before Einstein: the state before the metric substantiation of the interaction.

So if we aim at reconstructing various known physical relations based on the concept of metric and flow, these reconstructions will only be possible using the flow value of equation (9h). The factor 2, which occurs only due to the transition from a description in the flat spacetime to a relativistic description based on a change of the spacetime metric, does not appear.

I call such a system a "hybrid system", because it contains, on the one hand, the pre-metric view – which is indeed necessary for reconstructing relations that are based on this view – and, on the other hand, also the metric flow that is the fundamental concept of the metric description system.[19]

[19] By the way, I have always been wondering about the fact that the Schwarzschild solution of Einstein's field equations corresponds only to the Newtonian approximation in the case of sufficiently weak gravity, if, at the end of the derivation, as integration constant not m, but 2m (exactly: ln(2m)) is chosen. The geometric mass m and the Newtonian mass M are connected only by natural constants ($m = MG/c^2$). So why should a factor 2 occur here? I think, the explanation is exactly the fact that, in the non-relativistic description, there is no factor 2. It appears only at the transition to the relativistic view.

5. Gravitation → Antimatter

5.1. Matter and Antimatter as Opposite Metric Deformations

Under what circumstances disappears a metric deformation, which, associated with a metric flow, forms a stable, steady state? If and only if it meets the *opposite* metric deformation.

Matter and antimatter annihilate each other. From the metric-dynamic point of view, this means that the metric differences of matter and antimatter cancel each other out.

We assumed the metric defect described in the previous chapter to be the one of matter. The simplest formulation of this defect is that the continuum lacks a (metric) sphere with Radius m: in the metrically altered continuum, any radial distance from the center of gravity O is by m units *smaller* than in the undistorted continuum.

Therefore, in the case of antimatter must be assumed that any radial distance from the center is by m units *greater* than in the undistorted continuum; there is (so to speak) a metric sphere with radius m *too much*.

Let r be the distance of an arbitrary point from the center O in a Euclidean continuum, r_A the distance of the same point from O, measured in the continuum altered by antimatter. Then the following applies:

$$r_A = r + m \tag{26}$$

This means: If matter has the geometric mass m > 0, then the equal (symmetrical) amount of antimatter has the mass −m.

In the case of matter, according to (5) the metric density σ(r), is given by

$$\sigma = \frac{r - m}{r}$$

Thus, in the case of antimatter, we have to set

$$\sigma = \frac{r + m}{r} \tag{27}$$

We denominate the altered radial differential dr_A

According to the definition of σ

$$\sigma = \frac{dr}{dr'}$$

then applies $$dr_A = (1 + \frac{m}{r})^{-1} dr \tag{28}$$

5.2. Gravitation in the Case of Antimatter

Now we will determine the gravitation of antimatter, that is: the gravitation which follows from the metric defect that represents the opposite of the metric defect in the case of matter.

In order to determine the metric flow, (1) has to be rearranged as in Chapter 4, p37. (c is set to 1)

$$\frac{d\sigma}{dr} = -\frac{dv}{dt} \longrightarrow d\sigma = -\frac{dr}{dt} dv \tag{29}$$

Again we set $$\frac{dr}{dt} = v$$

$$d\sigma = -v\, dv$$

Integration gives $$\sigma = -\frac{v^2}{2} + C$$

According to (27), however, no longer applies

$$\sigma = \frac{r - m}{r}$$

but instead $$\sigma = \frac{r + m}{r}$$

Therefore $$1 + \frac{m}{r} = -\frac{v^2}{2} + C$$

The integration constant C follows again from the condition $v = 0$ for $r \to \infty$.

From this follows $C = 1$

This leads to $$\frac{v^2}{2} = -\frac{m}{r}$$

and, finally $$\boxed{v = \pm i\sqrt{\frac{2m}{r}}} \tag{30}$$

In the case of antimatter, the metric flow becomes imaginary.

Then, because of $v = \dfrac{dr}{dt}$, also r must be imaginary. (The time remains unchanged.)

If we replace in (1) v by iv and r by ir,

then $$\frac{d\sigma}{d\,i\,r} = -\frac{d\,i\,v}{d\,t} \qquad \text{(c set to 1)}$$

So we get $$\boxed{\frac{d\sigma}{dr} = +\frac{dv}{dt}} \tag{31}$$

If (1) is understood as relation of real-valued quantities – that is: of measurable quantities – then in the fundamental equation, in the case of antimatter the sign changes.

To determine the (real) flow-acceleration, we differentiate

$$\sigma = \frac{r + m}{r}$$ with respect to r.

This gives $$\frac{d\sigma}{dr} = -\frac{m}{r^2}$$

From (31) $$\frac{d\sigma}{dr} = \frac{dv}{dt}$$

then follows $$\boxed{\frac{dv}{dt} = -c^2\frac{m}{r^2}} \tag{32}$$

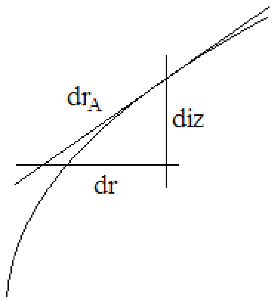
In the case of antimatter, the flow-acceleration is identical with that of matter. Thus the Newtonian approximation is in both cases identical.

Why do imaginary numbers occur in the case of antimatter? The reason is that here – as follows from (28)

$$dr_A = (1 + \frac{m}{r})^{-1}\, dr$$

– the radial differential dr_A, compared with the differential of undistorted space, is *shortened.*

Therefore, the usual description with an auxiliary dimension is only possible if this dimension is imaginary:



(S17)

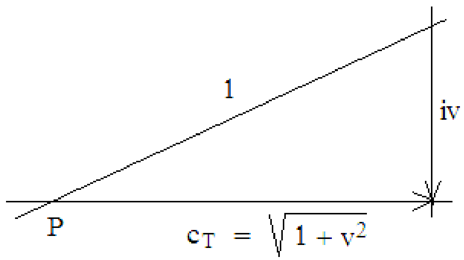
In (S17) is $dr_A^2 = dr^2 - dz^2$

Thus, only if the auxiliary dimension is imaginary, it applies $dr_A < dr$.

Or let us look at the flow:

$$v = -i\sqrt{\frac{2m}{r}}$$

If we now, as before in the case of matter, judge the velocity of the flow as it is seen non-relativistically "from outside", then this correction will lead – as can be seen in the following outline – to an *increase* of the light speed



(S18)

Here, the flow-corrected light speed c_T is greater than the normal light speed. This is simply because, in the case of antimatter, the circumferences of circles around the center O are *shorter* than in the Euclidean continuum. Therefore, the time that light requires for one orbit, is shorter – or, alternatively, light appears to be faster (of course only from a non-relativistic point of view.)

But from that follows now a difference between matter and antimatter:

In the case of antimatter, gravity is smaller than in the case of matter of identical mass |m|.

If the calculation of the perihelion precession is carried out exactly as in Section 4.3 of the previous chapter, however now, according to (S18), using the factor

$$k = \sqrt{1+v^2} = \sqrt{1+\frac{2m}{r}}$$

then the result is

$$\frac{\omega'}{\omega} = (1-\frac{2m}{r})^{\frac{3}{2}} \approx 1 - \frac{3m}{r} \qquad (33)$$

Thus there is no *precession* but a *retardation*: the ellipse rotates in the reverse direction, i.e. against the direction of motion.

Though the correction of the Newtonian approximation is completely analogous to the one in the case of matter, it leads not to an increase but to a decrease of gravity.

Now we determine the metric circumstances in a relativistic reference system S_A that rests relative to the center point O.

At first we must factor in – just in the same way as in the case of matter – that from a relativistic point of view the metric defect is not m but 2m. Any radial distance from the center is by 2m greater than in the undistorted continuum.

The length differential of the flow-system S_F is therefore (compare (14)):

$$dr_F = dr\,(1 + \frac{2m}{r})^{-1} \tag{34}$$

Now, from S_F can be transformed to a local (relativistic) observer system S_A, which is at rest relative to O, however not, as in the case of matter, with the factor

$$\sqrt{1 - \frac{2m}{r}}\ , \qquad \text{but with} \qquad \sqrt{1 + \frac{2m}{r}}$$

The reason for this change is that from

$$\frac{v}{c} = \pm i \sqrt{\frac{2m}{r}}$$

follows with respect to the factor of the Lorentz transformation:

$$k = \sqrt{1 - \frac{v^2}{c^2}} = \sqrt{1 + \frac{2m}{r}} \tag{35}$$

Thus the radial length differential dr_A of S_A is:

$$dr_A = dr_F\ k = dr\,(1 + \frac{2m}{r})^{-1}\ (1 + \frac{2m}{r})^{\frac{1}{2}} = dr\ (1 + \frac{2m}{r})^{-\frac{1}{2}}$$

and the time differential dt_A is (compare (17))

$$dt_A = dt\ (1 + \frac{2m}{r})^{\frac{1}{2}}$$

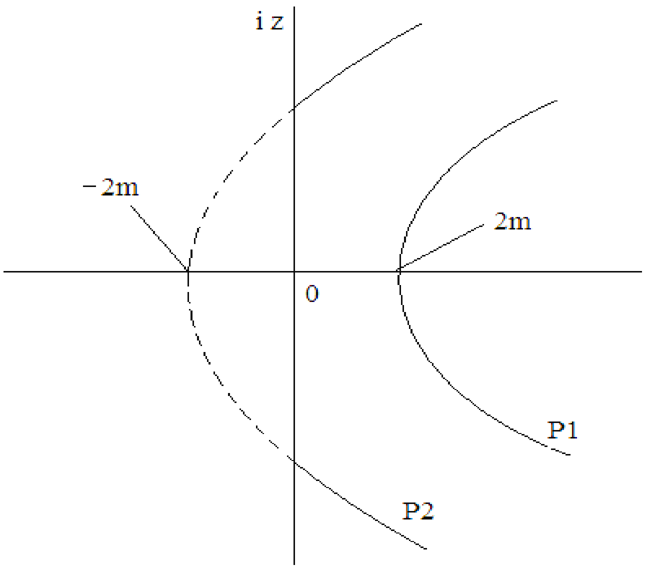
From this follows the metric:

$$ds^2 = (1 + \frac{2m}{r})\, dt^2 - (1 + \frac{2m}{r})^{-1}\, dr^2 - r^2\, d\phi^2 \qquad (36)$$

*In the case of antimatter, the metric is **not** identical with the Schwarzschild metric. In particular, the passing of time is not decelerated but accelerated.*

Thus, here objects are accelerated in the direction of the area of accelerated time.

For illustration of the metric circumstances, here an outline of the parabola P2, which – analogously to the Schwarzschild parabola – depicts the metric with the aid of an embedding dimension i z:



(S19)

P2 is the parabola, which illustrates the metric facts of (36). The auxiliary dimension i z is imaginary. (The Schwarzschild parabola P1 is shown only for comparison; for P1, the auxiliary dimension would of course have to be real.)

In the flow-concept, the metric circumstances are symmetrical for matter and antimatter.

Nonetheless this leads to a different gravitation.

5.3. Asymmetry of Matter and Antimatter

In addition to the different strength of gravity (in the case of the same m), there are also the following asymmetries between matter and antimatter:

In the case of matter, the following equations apply:

$$\frac{\partial \sigma}{\partial r} = -\frac{1}{c^2}\frac{\partial v}{\partial t} \tag{1}$$

$$\frac{\partial v}{\partial r} = -\frac{\partial \sigma}{\partial t} \tag{1a}$$

From these equations ensues the wave equation:

$$\frac{\partial^2 v}{\partial r^2} = \frac{1}{c^2}\frac{\partial^2 v}{\partial t^2} \tag{2}$$

But in the case of antimatter, the positive sign on the right side in (31)

$$\frac{d\sigma}{dr} = +\frac{1}{c^2}\frac{dv}{dt} \qquad \text{or rather} \qquad \frac{\partial \sigma}{\partial r} = +\frac{1}{c^2}\frac{\partial v}{\partial t}$$

prevents the derivation of the wave equation from (31) and (1a). Instead follows

$$\frac{\partial^2 v}{\partial r^2} = -\frac{1}{c^2}\frac{\partial^2 v}{\partial t^2} \tag{2'}$$

This means:

In the continuum that is metrically altered by antimatter, there are no stable longitudinal waves.

In the metric dynamic view, where everything that exists is understood as wave superposition, this represents a fundamental restriction.

The most important asymmetry, however, concerns the ***formation*** *of matter and antimatter:*

The metric dynamic universe consists of *flow-lines.*

The velocity of the metric flow along these flow lines, from the beginning to the end, has always a *real* value, with other words: the universe organizes itself exclusively through *real* longitudinal flows.

Antimatter, however, is characterized by the occurrence of an *imaginary* longitudinal flow.

From this follows:

Seen from the metric dynamic view-point, the assumption that always the same amount of matter and antimatter is generated cannot be maintained: within the global self-organization, matter evolves without antimatter being generated at the same time.

Locally, however, this assumption remains true: if locally a metrically densified area is generated, then a symmetric area of reduced metric density will evolve, which is surrounded by an area of imaginary metric flow; a *local* change of the metric density is not possible without the opposite local change. Therefore, in laboratory experiments, only particle-antiparticle pairs can be generated.

5.4. Summary

I close with a short summary.

Let K^3 be a 3-dimensional continuum, distorted by a geometric mass m.

If $m > 0$, then m is the geometric mass of *matter,* and any distance from the center O is by m length units *smaller* than in the undistorted continuum

If $m < 0$, then m is the geometric mass of *antimatter,* and any distance from the center O is by m length units *greater* than in the undistorted continuum.

In this way it is immediately clear why matter and antimatter with identical absolute value of m annihilate each other when they meet: the metric changes are opposite to one another and cancel each other out.[20]

The acceleration field, which corresponds to the Newtonian approximation, is in both cases identical:

$$\frac{dv}{dt} = -c^2 \frac{m}{r^2}$$

The metric flow toward the center is in the case of matter real, in the case of antimatter imaginary:

Matter: $$v_M = \pm c \sqrt{\frac{2m}{r}}$$

Antimatter: $$v_{AM} = \pm i\, c \sqrt{\frac{2m}{r}}$$

[20] The fact that energy is emitted in the form of waves at such an impact proves that matter and antimatter consist of waves, and it proves also that the respective metric changes are caused by these waves.

The squares of the flows cancel each other out:

$$v_M^2 \quad + \quad v_{AM}^2 \quad = \quad 0$$

From the fact that the metric flow caused by antimatter is imaginary follows that the gravitation of antimatter with mass –m is not identical with the gravitation of matter with mass m, but *weaker.*

The metric of the surrounding continuum is

$$ds^2 = (1 + \frac{2m}{r})\, dt^2 - (1 + \frac{2m}{r})^{-1} dr^2 - r^2\, d\phi^2$$

Thus time passes *faster* in the continuum distorted by antimatter.

There are further asymmetries between matter and antimatter:

1. In the case of antimatter, there are no waves of the longitudinal metric flow v and of the metric density σ.

*2. **Locally**, always the same amount of matter and antimatter is generated; **globally**, however, only matter is formed.*

Interim Report: The Metric Build-Up of the Description of Nature

The derivation of the metric-dynamic gravitation in Chapter 4 is an example of the method that I consider – as mentioned in the preliminary report – to be the main characteristic of the structure of my description of nature. I now want to go into this in a little more detail.

The requirements of the derivation and the derivation itself are purely metric:

Equation (1) [$\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}$] is assumed. It deals exclusively with metric facts: metric compression causes metric acceleration (more precisely: an acceleration of the metric flow).

In addition, there is the metric assumption (5) [$\sigma = \frac{r - m}{r}$], which states that *with* gravity the metric density of the radial length units in the external space is lower than *without* gravity.

Differentiating (5) in conjunction with (1) leads to the result (6) [$\frac{dv}{dt} = -c^2\frac{m}{r^2}$].

This result is again metric. However, it already represents Newton's approximation if m is understood as geometric mass.

Here, the derivation of the law of gravity occurs – I am tempted to say: *without any physics*, at least without the kind of physics which we are used to.

The connection with known physical quantities and facts only occurs when the length m is related to the Newtonian mass M (in kilograms) through the definition equation $m = \frac{MG}{c^2}$.

However, here this definition serves exclusively for the purpose of linking the result of the metric derivation – a completely abstract fact – with objective (concrete) experiences.[21]

---

[21] For example, I can place an object with the geometric mass m on a scale and in this way establish the connection with the usual mass M in kilograms, which is thereby *defined*. So, here, *defining* has the meaning: establishing a connection to a specific experience.

Thus the mass M in kilograms is no longer part of the causal structure. It loses its status as independent basic unit.

The causal structure itself remains limited to purely metric facts. This is of fundamental importance, because it is *the only way* causality can be substantiated. Although I will explain this in more detail in Chapter 11, I would still like to outline it here:

Equations (0) and (1), which we assume to describe the process by which reality comes into being, emerge from a series of argumentative steps, each of which is *necessary* because without it nothing would exist.

The same applies to the equations themselves: without them there would be nothing. Even if any part of them were left out, there would be nothing.

So these equations are necessary – as a whole and in each of their parts.

However, an equation that describes a real process is nothing other than the representation of a causal relationship: it can be read from left to right and from right to left: the right side follows from the left, and the left side follows from the right.

This means: Since we recognized equations (0) and (1) as *necessary*, we have proven a first causal relation.

If these equations actually describe the process that (permanently) produces reality, then follows that the laws which reality obeys can be derived from equations (0) and (1) and additional metric assumptions as constraints. Therefore to these equations also the following applies:

They inherit their causality to the laws derived from them and thus substantiate the causal relationships represented by these laws.

The fundamental equation (0) is therefore not only the origin of reality, but also the origin of causality.

The laws of gravity derived in Chapter 4 illustrate this fact: Since they follow logically from (1), they inherit the causality from (1).

In contrast, as stated at the end of the gravity chapter, it is impossible to establish gravity causally if the basic connection is *purely mechanical*, as in Newton's theory, or, as in Einstein's theory, *mechanical and metric*. These connections only exist *through experience*, and experience is *on principle* not sufficient to establish causality.

In all following chapters, we will proceed exactly in the same way as we did with gravity. The justification context will always be purely metric, and the connection to known physical facts will then be established by linking the metric quantities and facts with the usual mechanical quantities and facts, i.e. *through definition*, and this applies in particular to all units that previously had the status of independent basic units.

As with gravity, the definition serves in any case exclusively for linking the experiencable reality with the metric justification context, and not (e.g. as with Einstein's equation of gravitation) for representing the justification context itself.

The same thing will happen in the following chapter on the special theory of relativity, and also in the subsequent chapter on quantum theory: here, the photoelectric effect, the Compton effect, the double slit experiment and also the structure of the quantum mechanical formalism in general will be explained and justified in a metric-dynamic way.

The atomic structure will then again rely directly on equation (1), completely analogous to gravity, but this time starting from the change in the metric density of the angle: σ is interpreted as metric density of the angle, equation (1) turns into equation (1').

6. Waves with Light Speed → Special Theory of Relativity

6.1. Introduction

The special theory of relativity (SR) follows from two postulates:

1. The indistinguishability of uniformly moving systems with respect to all physical phenomena; this is the special principle of relativity.

2. The constancy of the speed of light for all uniformly moving observers.

The second postulate determines which transformation must be chosen at the transition from one inertial system to another: the transformation with respect to which the electromagnetic equations are covariant, i.e. the Lorentz transformation.

The a priori Galilean transformation is therefore only approximately valid; the Newtonian mechanics associated with it must be corrected.

There can be no doubt about the validity of the SR; it has been confirmed thousands of times. So there is no lack of evidence, but a complete lack of explanations that go beyond purely formal arguments or reference to experiments.

The usual reference to the fact that no movement can be claimed in relation to (empty) space is obviously inadequate. If it were suitable as an explanation, then accelerated systems would also have to be indistinguishable.

There are also reasons to assume that the passage of time depends on movement relative to (resting) space. Here is one of them:

Imagine a closed two-dimensional universe whose geometric structure corresponds to that of a spherical surface. In this universe there are two observers A and B who move uniformly relative to each other along the same great circle on the spherical surface. When they first meet, they both set their clocks to 0.

The question is: How will the clock comparison be at the next meeting?

There is no answer to that. A and B both move on geodesics. When viewed from A, time passes more slowly at B, and when viewed from B, time passes more slowly at A.

Of course, also other observers moving uniformly on this great circle with different speeds can be introduced, all of whom – according to the SR's argument – have the same right to judge the circumstances with respect to their frame of reference and therefore to expect a different result.

Only a second clock comparison that is *actually* carried out can provide information about how much time has *really* passed in all of these systems:

Obviously, of all possible observers, there is exactly one who was "right" when she saw her system as *resting*: it is the one whose time passes fastest. Her reference system can therefore actually be viewed as the *absolutely resting* system.

If we imagine the great circle opened and the ends extended against infinity, then this no longer seems to apply: A and B would then only meet again if one of the two turned back. So relativity could be assumed here.

However, the following speaks against this: Whether or not the passage of time in a physical system is determined by its movement relative to the surrounding *local* space cannot depend on the *global* structure of space.[22]

It follows that space is absolute in any case: Time *actually* passes fastest in a system at rest relative to space, though this fact would be undetectable, at least in an open universe.

There are also other reasons to see space as absolute. However I do not want to expand on this here, but rather continue the train of thought concerning SR where we left off at the end of Section 3.1.

6.2. Theory of Relativity without Relativity

In Chapter 3, we proved the following assertion:

There is only the speed of light. All other speeds must be derived from it.[23]

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[22] If you think otherwise, consider the following thought experiment: In an initially closed universe a constant decrease in mass occurs. Then a sudden transition from "absolute" to "relative" would have to be assumed, which would be nonsensical.

[23] Below (in Section 6.5) we will show that there is a surprisingly close connection between this assumption and the usual quantum mechanical representation of matter. However, this requires the Lorentz transformation, which should be derived beforehand.

Under this assumption, we will now both justify and explain the SR and then derive the Lorentz transformation without postulating the special principle of relativity or the constancy of the speed of light.

First we have to ask: *How can other speeds be generated from waves at the speed of light?*

The answer is: *By superimposing opposing waves.* We proceed as follows:

We represent the state of motion of stationary objects by superposition of waves with identical frequencies – i.e. by standing waves – and that of moving objects by superposition of waves with different frequencies.

We index the frequencies and wavelengths of the opposing waves with directional arrows ($_\rightarrow$ or $_\leftarrow$). All waves have light speed.

Let's call S the rest system. Let Ψ' be a superposition of two waves traveling in opposite directions with the frequencies $\nu_\rightarrow'$ and $\nu_\leftarrow'$. We are looking for the speed v of the system S' that is moving relative to S, in which Ψ' appears as a standing wave with a frequency ν_T . The conditions are then like in the usual Doppler effect, where an observer moving with v measures the same frequency for waves coming from the front and from behind.

Therefore applies $\quad \nu_\rightarrow' \; (1 - v/c) \; = \; \nu_\leftarrow' \; (1 + v/c) \; = \; \nu_T \qquad (1)$

It follows: $\quad \nu_\leftarrow' / \nu_\rightarrow' \; = \; (c - v) / (c + v) \qquad (2)$

and $\quad v / c \; = \; (\nu_\rightarrow' - \nu_\leftarrow') / (\nu_\rightarrow' + \nu_\leftarrow') \qquad (3)$

and also $\quad v / c \; = \; (\lambda_\leftarrow' - \lambda_\rightarrow') / (\lambda_\leftarrow' + \lambda_\rightarrow') \qquad (4)$

From (3) follows that the speed v of the object represented by the superposition depends on the frequencies of the opposing waves. Thus a change in speed is equivalent to a change in these frequencies.

By assumption, with respect to S', Ψ' is a standing wave with frequency ν_T. Let us now assume that Ψ' has emerged from a standing wave Ψ with frequency ν (with respect to S) by *acceleration* along a distance AB. (An object at rest has been accelerated to speed v.)

Our question is: Which frequency changes of the opposing waves correspond to this acceleration?

In the case of *any* acceleration, we assume for the frequencies of the waves traveling to the right

$$\forall\ \nu_{\rightarrow} :\quad \nu_{\rightarrow} \quad \mapsto \quad \nu_{\rightarrow}' \ = \ f(\nu_{\rightarrow}) \qquad (5)$$

and – as any wave which has traveled along AB, should, after the reverse travel BA, again have the original frequency – for the frequencies of the waves traveling to the left

$$\forall\ \nu_{\leftarrow} :\quad \nu_{\leftarrow} \quad \mapsto \quad \nu_{\leftarrow}' \ = \ f^{-1}(\nu_{\leftarrow}) \qquad (6)$$

We postulate the acceleration as independent of frequency. After inserting (5) and (6) in (3)

$$v / c \ = \ (\ f(\nu) \ - \ f^{-1}(\nu)\ )\ /\ (\ f(\nu) \ + f^{-1}(\nu)\ ) \qquad (\text{note} \quad \nu_{\rightarrow} \ = \ \nu_{\leftarrow} \ = \ \nu\ ) \qquad (7)$$

it is easy to see, that this postulate is met in the simplest way by setting

$$\nu_{\rightarrow}' \ = \ f(\nu_{\rightarrow}) \ = \ q\ \nu_{\rightarrow} \quad \text{and} \quad \nu_{\leftarrow}' \ = \ f^{-1}(\nu_{\leftarrow}) \ = \ q^{-1}\ \nu_{\leftarrow} \qquad (q \in R,\ \ q > 0) \qquad (8)$$

Then the equation of the velocity of the standing wave reads as follows:

$$v / c \ = \ (q\ \nu \ - q^{-1}\ \nu\ )\ /\ (q\ \nu + q^{-1}\ \nu\ )$$

or – after canceling the frequency

$$v / c \ = \ (q \ - \ q^{-1})\ /\ (q \ + q^{-1})$$

$$v / c \ = \ (q^2 - \ 1)\ /\ (q^2 \ + 1) \qquad (9)$$

According to (1) and (8):

$$\nu_T \ = \ \nu\, q\, (1 - v/c) \ = \ \nu\, q^{-1}\, (1 + v/c)$$

therefore $\nu_T^2 = \nu^2 (1 - v^2/c^2)$

and, at last $\nu_T = \nu \, (1 - v^2/c^2)^{1/2}$ (10)

Thus the frequency of Ψ' is reduced by the factor $(1 - v^2/c^2)^{1/2}$, compared with the frequency of Ψ.

In our model, there are only waves. Under this condition, times and lengths are *defined* by frequencies and wave lengths of standing waves.

Therefore (10) means:

In a reference system S' that travels with velocity v relative to the reference system S, time passes slower by the factor

$$k = \sqrt{1 - \frac{v^2}{c^2}} \tag{11}$$

Now we are prepared to face the fundamental question of special relativity. It is:

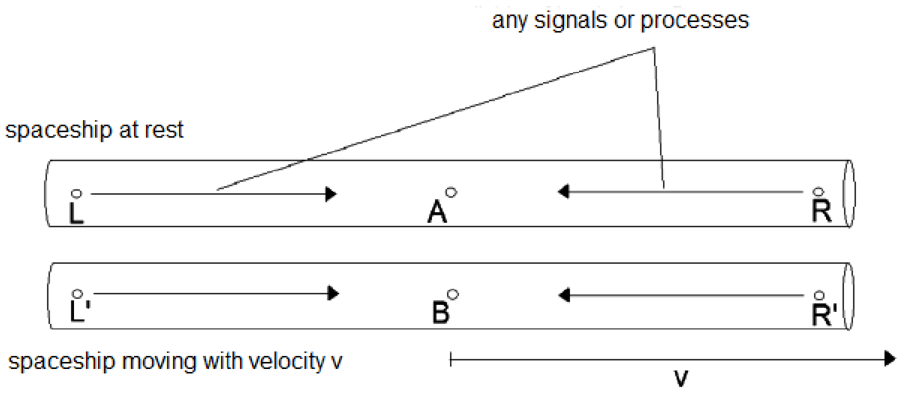
Why does nature obey the space-time relationships determined by light?

We will analyze and answer this question in the following, more concrete form:

Why do ***all signals*** (or processes, or moving objects) that arrive at a stationary observer ***simultaneously***, always arrive at a uniformly moving observer ***with the same time difference as light signals*** that were emitted at the same time and at the same positions as the other signals?

We illustrate this fact with an example:

Let's assume A and B are observers in spaceships. Let's call A's spaceship the stationary one. Let B's spaceship move relative to A with velocity v.



(S1)

LA = AR = L'B = BR' (with respect to A at the point in time that is represented in the sketch)

(We don't need to worry about the relativistic length contraction: L' and R' are not supposed to be the relativistically transformed points L and R, but two points that agree in their x-coordinates with L and R (with respect to the stationary observer A) at the moment in which – as shown in the sketch – the two observers oppose each other.)

In R and R', L and L', light signals are generated, simultaneously with respect to A. They reach A at the same time and B with the time difference Δt.

However, at the same time as the light signals and at the same positions, also other signals are generated, let's say: sound signals in the metal body of the spaceships or in the air they contain. (You could also shoot bullets or do allotria in some other way.)

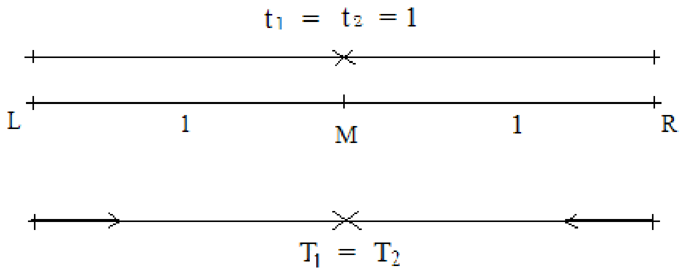
First the light signals arrive at B, and then, at different time intervals, the other signals. But to all pairs of identical signals or processes the following must apply:

The time difference Δt, with which they reach B, is always the same, and it corresponds to the time difference of the light signals. Only under this condition can the times determined by light be universally valid.

Since neither the validity of the principle of relativity nor the constancy of the speed of light is assumed here, the equality of these time differences cannot be postulated, but must first be shown.

Let us now return to the general train of thought that we illustrated with this example.

First we look at the resting system S. Let M be the mid point of the line segment LR.



(S2)

The upper arrows represent light rays. t_1 and t_2 are the time points when the light rays from R and L arrive at M ($t_1 = t_2$).

The lower arrows represent objects, which travel from L and R towards M with equal velocity. T_1 and T_2 are the time points of their arrival ($T_1 = T_2$). The distances between M and R and between M and L are 1.

The object at L is represented by a superposition of waves with the frequencies $\nu_{\rightarrow} = a$ and $\nu_{\leftarrow} = b$, accordingly the object at R by a superposition of waves with the frequencies $\nu_{\rightarrow} = b$, $\nu_{\leftarrow} = a$ ($a > b$). At M, an object at rest is located with $\nu_{\rightarrow} = \nu_{\leftarrow} = m$.

Let v_L be the velocity of the object at L, v_R the velocity of the object at R ($v_L = -v_R$), and v_M the velocity of the object at M ($v_M = 0$).

Now we change over into a system S' which travels uniformly to the right with velocity v_M'.

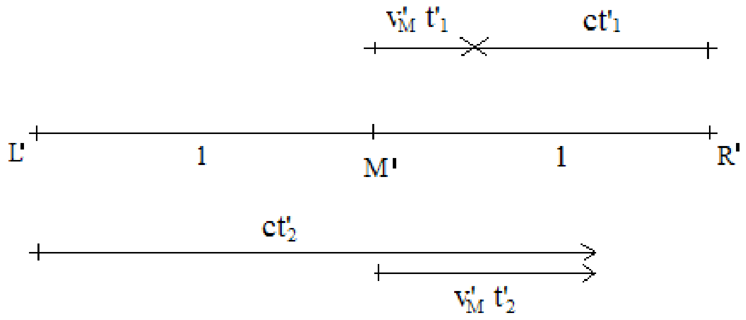
S' is defined in the following way: the *same* objects as before in S – which however now we denominate L', M' and R' – are located at the same positions at the same time point t = 0, but *after an acceleration*, that is: transformed according to (8).

Therefore their frequencies can be determined by multiplying or dividing the frequencies of the corresponding objects in S by a real number q > 0.

Now we will demonstrate, using this scenario, that the time difference of the arrivals of the moving objects is equal to the time difference of the arrivals of the light rays.

First we calculate the time difference, with which the light rays emitted from L' and R' (simultaneously with respect to the system at rest) arrive at M'.

From the below outline



(S3)

the following relationships can be read off:

$$v_M' \, t_1' + c \, t_1' = 1 \,, \quad - v_M' \, t_2' + c \, t_2' = 1$$

According to (9) applies

$$v_M' = c\,(q^2 - 1) / (q^2 + 1)$$

Therefore

$$(c\,(q^2 - 1) / (q^2 + 1))\, t_1' + c\, t_1' = 1\,, \qquad t_1' = (1 / c)\ ((q^2 + 1) / (2q^2))$$

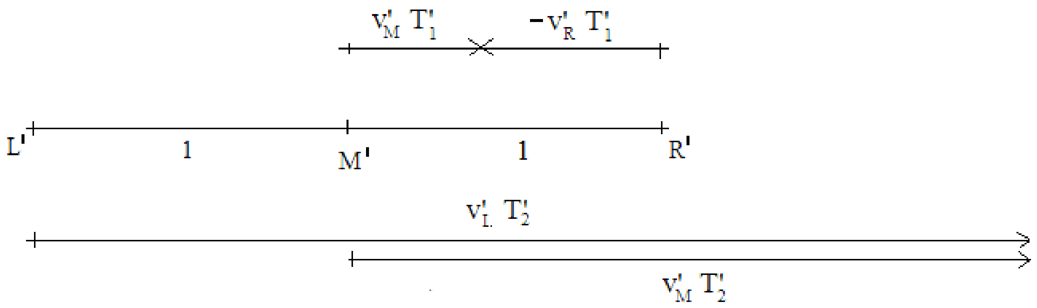
$$-(c\,(q^2 - 1) / (q^2 + 1))\, t_2' + c\, t_2' = 1\,, \qquad t_2' = (1 / c)\ ((q^2 + 1) / 2)$$

From this follows

$$t_2' - t_1' = (1 / c)\ ((q^4 - 1) / (2q^2))\,. \tag{12}$$

Thus this is the time difference with which the *light rays* arrive at M'.

Now to the time difference, with which the *objects* arrive at M'.



(S4)

$$-v_R'\, T_1' + v_M'\, T_1' = 1\,, \quad v_L'\, T_2' - v_M'\, T_2' = 1$$

According to (3) and (8) applies

$$v_L'/c = (a\, q - b\,(1/q)) / (a\, q + b\,(1/q)) = (a\, q^2 - b) / (a\, q^2 + b)$$

$$v_R'/c = (b\, q - a\,(1/q)) / (b\, q + a\,(1/q)) = (b\, q^2 - a) / (b\, q^2 + a)$$

As before, $v_M' = c\,(q^2 - 1) / (q^2 + 1)$

The short calculation leads to:

$$T_2' - T_1' = (1 / c)\,((q^4 - 1) / (2q^2)) . \tag{13}$$

The comparison with (12) shows:

$$T_2' - T_1' = t_2' - t_1' .$$

The time difference of the arrivals of the moving objects at M' is equal to that of the light rays.

Thus we have demonstrated:

If a resting system S is changed into a system S' by transforming all objects of S according to (8), then all symmetrical signals (processes, objects) – traveling at light speed or at any other arbitrary speed – which arrive at M in S simultaneously, arrive at M' in S' with the same time difference Δt.

Therefore, points located ahead of M' must be shifted into the past with respect to an observer in M', and points behind M' into the future.

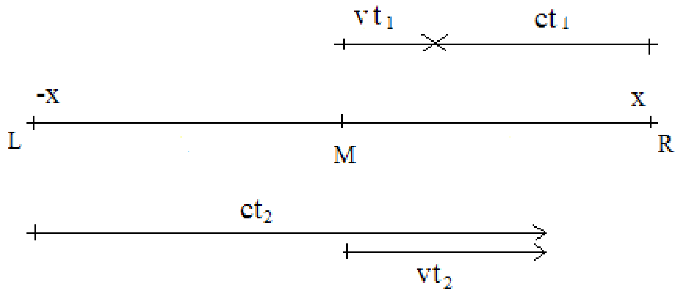
6.3. Derivation of the Lorentz-Transformation

If *now* the measures of space and time are determined by light signals (on the basis of Δt), then this is *not* substantiated by the principle of special relativity and by the principle of the constancy of light speed for all uniformly moving observers, but by the fact that – due to the above result – it is *already known* that the spacetime measures determined by light hold true for all physical processes and events.

For the sake of simplicity, in the following we will omit the dashes of the primed quantities that belonged to the moving system, and also denominate v_M' as v.

The scenario is now again the one that Einstein invented.

From L and R light rays are emitted, simultaneously with respect to an observer resting at M. The sketch shows how the time-points can be determined at which the light signals hit an observer that moves with v:



(S5)

The outline shows that

$$t_1 \;=\; x/(v+c) \qquad t_2 \;=\; x/(-v+c)$$

$$t_2 - t_1 \;=\; 2\,vx/(c^2 - v^2) \;=\; 2\,(vx/c^2)/(1 - v^2/c^2)$$

Thus if, with respect to the resting observer, the signal from point R is emitted at the time $t_R = 0$, then, with respect to the moving observer, this time point must be shifted by the interval

$$(vx/c^2) / (1 - v^2/c^2)$$

into the past: the signal arrives at the moving observer earlier than at the resting observer. (Half of the time difference, because the origin of coordinates of both systems lies in the middle between L and R and the dependency from x is linear.)

Accordingly, with respect to the moving observer, the time point $t_R°$ of the emission of the signal from R is given by

$$t_R° = -(vx/c^2)/(1 - v^2/c^2)$$

Let us now assume, the signal is not emitted at the time 0 but at an arbitrary time t from a point located at the distance x from the resting observer.

Then, with respect to the moving observer, the x-coordinate of this point has been diminished by vt, and it follows (by inserting the value of x and adding t)

$$t° = t - (v(x - vt)/c^2)/(1 - v^2/c^2)$$

$$t° = (t - v^2t/c^2 - vx/c^2 + v^2t/c^2)/(1 - v^2/c^2)$$

$$t° = (t - vx/c^2)/(1 - v^2/c^2) \qquad (14)$$

The coordinate x° that belongs to this altered time t°, results from

$$x° = x - vt°$$

$$x° = x - v(t - vx/c^2)/(1 - v^2/c^2)$$

$$x^\circ = (x - xv^2/c^2 - vt + xv^2/c^2)/(1 - v^2/c^2)$$

$$x^\circ = (x - vt)/(1 - v^2/c^2) \tag{15}$$

So far only the time shift along the x-axis has been taken into account. However, it must also be factored in that, according to (11), in the moving system the time is passing slower by the factor k.

Therefore we set

$$t' = t^\circ \sqrt{1 - \frac{v^2}{c^2}}$$

Then follows from equation (14)

$$t' = ((t - vx/c^2)/(1 - v^2/c^2))\sqrt{1 - \frac{v^2}{c^2}}$$

$$t' = (t - vx/c^2)/\sqrt{1 - \frac{v^2}{c^2}} \tag{16}$$

Lengths and times are connected by $x^\circ = ct^\circ$. Therefore also applies that

$$x' = x^\circ \sqrt{1 - \frac{v^2}{c^2}}$$

$$x' = (x - vt)/\sqrt{1 - \frac{v^2}{c^2}} \tag{17}$$

(16) and (17) are two of the four equations of the Lorentz-Transformation. About the other two, nothing further has to be said.

6.4. Remark

Basis of our considerations was the time difference Δt. However it would also have been possible to start with the formula for the velocity addition, which here, according to (9), assumes the following form:

Let be $v = c\,(q_1^2 - 1) / (q_1^2 + 1)$, $w = c\,(q_2^2 - 1) / (q_2^2 + 1)$

Then it can be shown by a simple calculation that the combined velocity W, which is composed of v and w, is given by

$$W = c\,\frac{q_1^2\,q_2^2 - 1}{q_1^2\,q_2^2 + 1} = \frac{v + w}{1 + vw/c^2}$$

q corresponds to the factor of the relativistic Doppler effect:

From equation (9) follows $q = \sqrt{\dfrac{1 + v/c}{1 - v/c}}$

6.5. The Short Path to Matter

It seems as if the hypothesis "There is only the speed of light" lies far outside, at an almost absurd distance from "normal" physics. Therefore, it shall now be shown that this is not the case, but that, on the contrary, a very short path leads back to the usual physical modeling.

Let S1 be a reference system at rest, S2 a system moving relative to S1 with speed v. An object at rest with respect to S2 is represented by a wave superposition in the form of a standing wave:

$$y = \sin(2\pi\, f\, t)\cos(2\pi\, x\, \frac{1}{\lambda}) \qquad (f\lambda = c)$$

Transformation into resting system S1 leads to the wave superposition

$$y = \sin 2\pi\,(t\, f\, \frac{1}{k} - x\, f\, \frac{v}{c^2}\frac{1}{k})\ \cos 2\pi\,(t\, v\, \frac{1}{\lambda k} - x\, \frac{1}{\lambda k}) \qquad (\ k = \sqrt{1 - \frac{v^2}{c^2}}\ )$$

The *first* of the two waves is a *de Broglie matter wave.*

It has the frequency $f\,\frac{1}{k}$, the wave length $\frac{1}{f}\frac{c^2}{v}\,k = \lambda\,\frac{c}{v}\,k$ (λ Compton wave length)

and the phase velocity $u = \frac{c^2}{v}$.

The *second* wave has the velocity v, which is the velocity of the particle that is associated with the matter wave.

So the following applies:

Seen from the system at rest, a standing wave in a moving system that is generated by two waves traveling at the speed of light, is the superposition of a matter wave and a wave with the speed of the group, i.e. of the associated particle.

In other words: material being – exactly what seems to be in stark contradiction to the claim "There is only light speed" – can be reconstructed from exactly this assumption in the shortest possible way – at least in de Broglie's representation, which however is of course the maximum of what can be achieved with our simple, one-dimensional model.

6.6. Summary

In this chapter, as announced, we have derived the special theory of relativity without postulating the special principle of relativity or the constancy of the speed of light for all uniformly moving observers.

The question: ***"Why does nature obey the space-time relationships determined by light?"*** we have answered as follows:

Nature obeys the space and time relationships determined by light signals because there is only light speed and phenomena derived from it.

Our calculations were based on metric waves that propagate at the speed of light.

We established the following differences from the usual perspective:

Space – which here always means: *metric space* or *metric* – is *absolute*. The *symmetry* that exists under certain conditions (large-scale distortion-free metric), i.e. the equality of uniformly moving systems, relates to the description bot not to the reality.

The same applies to the *merging* of space and time: it only occurs in the description, in other words: it applies to ***space and time measurements*** and ***not to space and time themselves.***

Their mutual dependence is a mathematical fact and not an indication that they themselves lose their independence and only exist in the form of the 4-dimensional space-time continuum.[24] This also applies when gravity is included: coordinate transformations are a purely formal act that serves

[24] E.g. Hermann Minkowski 1909: "Von Stund' an sollen Raum für sich und Zeit für sich völlig zu Schatten herabsinken und nur noch eine Art Union der beiden soll Selbständigkeit bewahren." (From now on, space for itself and time for itself should sink completely into shadows and only a kind of union between the two should maintain independence.)

to gain information. The values of the space and time measurements depend on each other and form a 4-dimensional structure, but space and time themselves remain separate.

With other words: *Formally,* space and time constitute a mathematical unity. *Ontologically,* they retain their identity.

This is actually self-evident: Reality *is* change. *In itself,* there is no time, only change. *In a description,* however, time is needed to represent this change.

The identification of reality and description that Einstein performed [25] – and many physicists have followed him in this idea – leads to the false conception of a time that exists like space and is just not accessible to us; Given this conception of time, it remains inexplicable why we cannot move willingly into the past or into the future.

In this chapter we once again used exclusively metric facts for our calculations and conclusions:

The waves with light speed that we assumed are *metric* waves. Both speed and acceleration were defined in a metric way.

At no point was it necessary to include physical terms and facts. Everything arose directly from the metric context of reasoning.

---

[25] After the death of his friend Michele Besso – on March 31, 1955, a few weeks before he himself died – Einstein wrote to Besso's family: "For us believing physicists, the distinction between past, present and future has only the meaning of an illusion, albeit a stubborn one."

About this, the following should be said: This illusion is not only *stubborn*, but *insurmountable* – simply because it is not an illusion. The infinite extension of the time coordinate does not indicate an infinitely available reality, as is the case with the spatial coordinates. Actually, only the totality of the local – causally connected and constantly changing – present moments exists.

In itself, there is only the ever-changing space. Time exists only *for us:* we need it to describe the change of space.

7. Waves with Light Speed → Quantum Theory

7.1. What Really Happens in the Double-Slit Experiment

The insights we have gained along the way so far give rise to the assumption:

There are only waves.

Based on this assumption, we now turn to the icon of quantum mechanical mystery: the *double-slit experiment*.

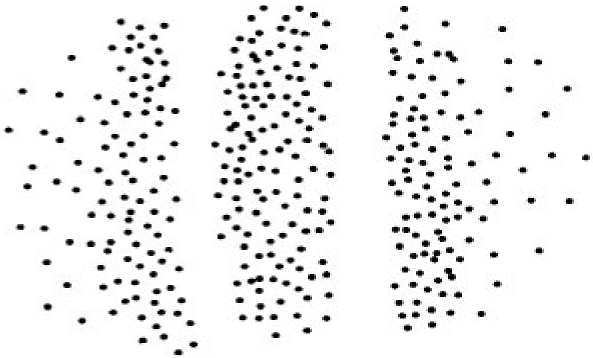
The following is an attempt to present, in the simplest possible way, a realistic and local interpretation of what actually occurs in the double slit experiment. To make it clear what kind of problems we are dealing with, I think the sentences are suitable, with which Richard Feynman, who himself made some important contributions to quantum mechanics, begins his description of the experiment:

"In this chapter, we shall tackle immediately the basic element of the mysterious behavior in its most strange form. We choose to examine a phenomenon which is impossible, absolutely impossible, to explain in any classical way, and which has in it the heart of quantum mechanics. In reality, it contains the only mystery. We cannot explain the mystery in the sense of 'explaining' how it works. We will 'tell' you how it works. In telling you how it works we will have told you about the basic peculiarities of all quantum mechanics." (Feynman, Leighton, Sands, Lectures on Physics Vol. 1, 37–2, Addison-Wesley 1965)

Since there are already thousands of representations of the experiment, I will limit my description to the absolute minimum of facts and initially completely ignore technical details.

We create individual electron particles and let them pass through a double slit. We ensure that only one single electron at a time is in motion in the experimental setup. Behind the double slit there is a detector plate that indicates the impact of an electron through a black dot.

After some time we observe the following pattern on the detector plate:



(S0)

So there is ***interference***, and it follows that the electron must have behaved ***wave-like*** as it passed through the double slit, since successive ***particles*** cannot create this pattern. However, the observable consequence of the appearance of an electron on the detector plate – the black dot – can only be explained by the fact that the electron that hit there is now again ***particle-like***.

The formal connection between the wave and the observed particle is quite simple: the probability that the particle will appear at a certain point follows from the square of the wave amplitude at that point.

So ***mathematically***, everything is clear: we determine the equation of the wave and calculate the probabilities. But can we also ***understand*** what is happening?

What about the wave after the electron appears? Since only ***one*** electron was traveling and we have now measured ***one*** electron, the wave must obviously have disappeared afterwards. But how is that possible? Since the square of its amplitude gives the probability of the electron's appearance, the wave must have something to do with this event – somehow it seems to have triggered it. So we actually feel compelled to attribute ***existence*** to it, all the more so since the ***interference*** also indicates that ***something*** exists ***that*** interferes – but its disappearance prevents us from assuming the existence of the wave.

In addition, we are confronted with the question of ***how*** and ***why*** this strange transition from wave to particle occurs.

Let's hear what the fathers of quantum theory say about this:

Nils Bohr: "There is no quantum world. There is only an abstract quantum mechanical description. It is wrong to think that the task of physics is to find out how Nature is. Physics concerns what we can say about Nature." (A. Petersen, Bulletin of the Atomic Scientist 19, 12 (1963))

Werner Heisenberg: "In the experiments about atomic events we have to do with things and facts, with phenomena that are just as real as any phenomena in everyday life. But the atoms or the elementary particles are not as real; they form a world of potentialities or possibilities rather than one of things or facts." (Physics and Philosophy, p. 160, Allen and Unwin, London (1958))

It is worth emphasizing that Bohr's and Heisenberg's statements do not clarify the situation in the least. They are simply retreat positions. I prefer Richard Feynman's point of view, which calls a spade a spade and doesn't sugarcoat anything:

"I think it is safe to say that no one understands quantum mechanics. Do not keep saying to yourself, if you can possibly avoid it, 'but how can it be like that?' Because you will go 'down the drain' into a blind alley from which nobody has yet escaped. Nobody knows how it can be like that." (Richard Feynman, The Character of Physical Law, Penguin 1992, p. 129)

Even today, after a hundred years of quantum mechanics, there are still physicists, philosophers and interested laypeople who are struggling with the question: *How is this possible?* But actually it's a cold case. Since everything works satisfactorily, almost all physicists have retreated to a pragmatic point of view.

Anyone who continues to ask can choose between a number of "possible worlds" that have been proposed since the introduction of quantum mechanics. But since none of these worlds even *begins* to solve the problems, I will refrain from introducing them.

I only want to mention one, but actually only because I'm a fan of fantasy: the so-called *many-worlds theory*, which has taken pop culture by storm.

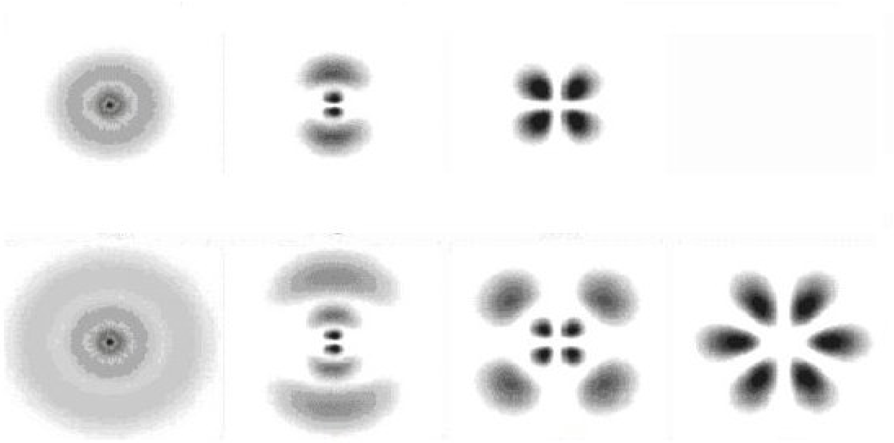
Here the wave does not disappear, but rather it is assumed that at the moment of measurement (howsoever one determines this point in time) the universe splits into as many almost identical copies of itself as there are possible measurement results.

The variants of the universe then differ from each other only with regard to this result. However, the most important element of quantum mechanical representation, probability, is lost in this bizarre proposal, and the questions of *how* and *why* the wave becomes the particle are also not answered.

So much for the status quo. However, let us now turn to our actual task, the answer to the question:

What really happens in the double slit experiment?

First, we consider some possible ***vibration states of a sphere*** (the gray values correspond to the squares of the wave amplitudes):



(S1)

But the wave structures shown are ***electron shells of atoms***.

So, based on our assumption: ***"There are only waves"***, we assume:

Electron shells <u>are</u> three-dimensional standing waves in the form of spherical waves.

Therefore, what is usually understood as *"number of electrons"*, here corresponds to the *number of oscillation areas that are separated by nodal surfaces*.

When an "electron" detaches itself from such a standing wave, a new state is formed: the state with one node area less.

From our perspective this means:

Part of the ***standing wave*** *has broken away and is now traveling as a* ***running wave****.*

Given this assumption, we are now in a position to explain what happens in the double slit experiment:

> First, as just described, an electron breaks away from a shell: a part of the spherical wave has become a running wave.
>
> This traveling electron wave then crosses the double slit and then, as expected, does exactly what waves do: it diverges and interferes with itself. Then it hits a detector plate.
>
> But the detector plate is nothing other than the aggregation of an enormous number of objects of the type shown in the sketch above. The *running electron wave* therefore meets a *standing electron wave* wherever its amplitude is not zero.
>
> And then? Very simple: then the incoming running wave is added to the local standing waves. At each of these standing waves, it can trigger a transition to the next higher state – i.e. to the state with one node area more. The probability of such a transition depends on the square of the local wave amplitude.
>
> In the usual perspective this means: an electron has appeared at this point.
>
> What about the rest of the running wave? Well, of course it does *not* disappear, but, as just stated, it adds up to the standing waves everywhere and thereby increases the probability of future transitions.

And that's all! The whole process can be explained in this extremely simple way.[26]

But even within the framework of this ultra-brief explanation, it is appropriate to address at least one question that immediately arises:

The electron wave that diverges after the double slit is expanded to macroscopic dimensions even at a short distance from the double slit. Its local amplitude is therefore extremely tiny everywhere.

So how could it trigger a transition?

The answer is simple. In the case of standing electron waves, we encounter the same circumstances as with any other standing waves: if we observe them in a certain state defined by the number of nodal surfaces, then that does not mean they are *identical*. Some of them may be very close to the

---

[26] Some important additions will follow in Section 9.11: only there the means are available through which spin and angular momentum can be integrated into the concept of standing electron waves. To the question, ***what** actually oscillates*, see here.

"jump" to the next higher state, others just as close to the jump to the next lower state, many will be in the middle range.[27]

It is therefore only necessary to assume that at some position on the detector plate the state of the local standing electron wave is so close to the jump that the local amplitude square of the running electron wave – as tiny as it may be – is still sufficient to trigger this jump.

A very important implication of this explanation is that the electron that appears on the detector plate is by no means identical with the electron that was generated before the double slit.

The share that this previously generated electron has in the newly-generated standing wave, which has just made the jump to the higher state, is, according to what has just been said, extremely small. The majority of the entire standing wave – and therefore also the majority of the additional oscillation area created by the jump (the "extra electron") – consists of waves that were already present before the traveling electron wave hit.

In short: **The detected electron is not identical with the previously created electron.**

(See also the comments in the Final Report on page 315.)

Remark:

For more than hundred years, the field of quantum theoretical interpretation has been a playground for the most abstruse ideas. The admission of ignorance might be accepted, but its obfuscation by producing nonsense is unforgivable. I will not go into these interpretations.

---

[27] Think, for example, of standing air waves in a pipe that are created by blowing on the pipe. They too can only exist in a discrete sequence of states, namely in exactly those in which the length of the tube is an integer multiple of half the wavelength. Even if the state of the wave is very close to jumping to the next higher – or the next lower – overtone, we still hear (almost) the same tone. But even the slightest change in the lip tension would be enough to trigger this jump.

If one were to follow the language of quantum mechanics, then one would have to refer to the oscillation areas inside the tubes as "particles", and the differences between the overall oscillation states in different tubes – which nevertheless have the same number of half wavelengths – would be understood as differences in the probability amplitudes of states that are superimposed in these tubes.

Only very few physicists have seriously tried to find reasonable solutions. The best known among them are Schrödinger and Einstein. However, their attempts at explanations were inadequate:

Schrödinger had initially hoped he could use his "wave function" to generate wave packets that remained tightly localized. So he wanted to model *particles* using waves and thus avoid the explicit assumption of particles, i.e. the wave-particle dualism. However, Bohr proved to him that this is not possible because the wave packets (almost) always diverge.

Einstein, on the other hand – no doubt motivated by his success in describing the photoelectric effect – wanted to maintain the classical idea of the independent existence of quantities such as position and momentum, in the form of the so-called "objective dualism" (particles within guiding waves). As it eventually turned out, however, it is precisely this assumption that enables Bell's proof of non-locality and thus serves to refute Einstein's own convictions. (More about this in Chapter 8.)

So both Schrödinger and Einstein ultimately failed by clinging to the idea that electrons – and other elementary particles – are localized entities whose existence is maintained throughout.

However, according to the above explanation of the double slit experiment, this assumption is wrong.

On how we will proceed:

The claim "There are only waves" is obviously in contrast to wave-particle dualism, which is generally believed to be indispensable for describing quantum mechanical scenarios. In order to refute this belief, it is necessary to show that the concept "particle" – at least in its usual form – can be dispensed with.

We will begin with the two scenarios through which the dualism of radiation entered physics: the photoelectric effect and the Compton effect. Afterwards we will deal with the dualism of matter in general.

The basic facts needed to eliminate dualism are already contained in the brief explanation of the double slit experiment. However, they still require generalization.

In all cases it will turn out that abandoning the concept "particle" not only can be done without loss, but that it is actually *necessary* in order to gain a clear and consistent idea of what really occurs in quantum mechanical scenarios.

According to our previous line of arguing, all justifications will again be purely metric, and the connection to known physics – and thus at the same time to tangible facts – will then be established through definition equations.

7.2. The Photoelectric Effect

The experimental facts about the photoelectric effect:

If a metal plate is irradiated with UV light whose frequency ν is above a limit ν_{min}, then electrons are released without any measurable delay, the kinetic energy of which only depends on the frequency ν of the radiation.

This is in blatant contradiction to the wave model of light, according to which the energy of the electrons should depend on the intensity of the light and their separation should occur at any frequency.

Furthermore, an enormous delay (thousands of hours under realistic conditions) would have to be expected until the first electron is detached, if one assumes that the light energy irradiated onto an area of the order of magnitude of the electron cross-section would have to add up to the required value.

As is well known, Einstein's solution is to view the interaction between light and matter as a collision process of particles, namely a light quantum with the energy $h\nu$ and an electron that is bound with the energy A. The relationship then results from the energy balance

$$h\nu = A + \frac{m v^2}{2} \qquad (A \ldots \quad \text{displacement work}) \qquad (1)$$

When the interaction is presented in this way, the result is consistent with experiment. In this respect, it is justified to regard this as a successful description.

According to our assumptions, however, and in order *to understand* what actually happens, we have to obtain the same result based on the hypothesis that both light and electron are waves.

How can waves actually interact *as waves*? The easiest way is *through superposition*. So we will represent the interaction as a superposition of two waves.

First, a preliminary consideration: If the electron is a wave, then an oscillation must exist in the electron. We denote the frequency of this oscillation with ν. For a resting electron we set

$$y = \cos 2\pi\, t\, \nu$$

(This is the well-known assumption of Louis de Broglie in his introduction of "matter waves".) For an electron moving with speed v, from the Lorentz transformation results

$$y = \cos 2\pi \left(t\, \nu \frac{1}{k} - x\, \nu \frac{v}{c^2} \frac{1}{k} \right) \qquad \left(k = \sqrt{1 - \frac{v^2}{c^2}} \right)$$

Thus the frequency ν_e of an electron moving with speed v relates to the frequency ν_{e_0} of an electron at rest as follows:

$$\frac{\nu_e}{\nu_{e0}} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} = \frac{1}{k} \tag{2}$$

In the case of non-relativistic electrons, v is small against c, and therefore

$$\frac{1}{k} = \frac{1}{\sqrt{1 - \frac{v^2}{c^2}}} \approx \frac{1}{1 - \frac{v^2}{2c^2}} \approx 1 + \frac{v^2}{2c^2} \tag{3}$$

Now we proceed to the description of the interaction. At first, we look at the interaction between light and a free electron.

Let ν_{e_0} be the frequency of a free electron at rest before the interaction, ν_e the frequency of the electron moving with velocity v after the interaction.

We form a superposition of the in-phase oscillation which represents the electron[28]

$$y = \cos 2\pi\, t\, \nu_{e_0}$$

and a plane wave that represents the light

$$y = \cos 2\pi \left(t\, \nu_L - x \frac{1}{\lambda_L} \right)$$

From the identity:

$$2 \cos a \cos b = \cos(a + b) + \cos(a - b) \tag{4}$$

follows that, as a consequence of the superposition, we obtain two waves with the frequencies

$$\nu_{e_0} \pm \nu_L$$

where ν_L is the frequency of the light.

The higher frequency must be the frequency of the electron that is *accelerated* by the interaction; thus, according to (2), it follows that

$$\nu_e = \nu_{e_0} + \nu_L = \nu_{e_0} \frac{1}{k} \tag{5}$$

(The second wave will be discussed subsequently)

---

[28] Of course it cannot be claimed that the electron *is* this oscillation. However from the occurrence of this oscillation conclusions can be drawn.

Then $\quad \nu_L = \nu_{e_0} \left(\frac{1}{k} - 1\right) \quad$ and according to (3)

$$\nu_L = \nu_{e_0} \frac{v^2}{2c^2} \tag{6}$$

Thus also here, the square of the speed of the electron is proportional to the frequency of the light.

(For the second wave we would have to set

$$\nu_e = \nu_{e_0} - \nu_L = \nu_{e_0}\, k \tag{5'}$$

However according to (3) $\quad k \approx 1 - \frac{v^2}{2c^2}$

and we again obtain $\quad \nu_L = \nu_{e_0} \frac{v^2}{2c^2}$

The frequency of the second wave would therefore correspond to the frequency of an electron, whose velocity is *reduced* by v as a consequence of the interaction. Since we assumed a stationary electron – so that ν_{e_0} cannot be reduced any more – this part can be omitted.)

Up to now, we have only used simple wave-mathematics. In order to return into the world of physical modeling, we multiply (6) by h:

(It should be emphasized, however, that this multiplication is only necessary due to "dimensional" reasons, i.e. for crossing over to the “mechanical” description. The fact that h is a fundamental *unit* has nothing to do with our considerations. We will discuss this point later.)

$$h\nu_L = h\nu_{e_0} \frac{v^2}{2c^2} = m_e c^2 \frac{v^2}{2c^2} \tag{6'}$$

Eventually we obtain $$h\nu_L = \frac{m_e v^2}{2} \tag{7}$$

In order to transfer our idea to the interaction between light and a bound electron, now we only have to insert the frequency difference δ_ν between a bound and a free electron into (5)

$$\nu_e = \nu_{e_0} + \nu_L - \delta_\nu = \nu_{e_0} \frac{1}{k} \tag{8}$$

and to carry along this δ_ν, therefore

$$h\nu_L - h\delta_\nu = h\nu_{e_0} \frac{v^2}{2c^2} = m_e c^2 \frac{v^2}{2c^2} \tag{8'}$$

So we get to

$$h\nu_L = \frac{m_e v^2}{2} + h\delta_\nu \tag{9}$$

which is identical with (1).

.

Let us now compare the two models – the usual one, which is analogue to a mechanical impact, and the one proposed here, which is conceptualized as wave-superposition.

In the mechanical impact model, the fact that the velocities and, accordingly, the energies of the electrons after the interaction are always identical and depend only on the light frequency necessitates the well known interpretation, i.e. light particles, which are defined by frequency and are always identical and indivisible, interact with electrons. (If the light particles were divisible or different from each other we should see also electrons with different velocities after the impacts.)

In the wave model, on the contrary, this fact is self-evident: here, the "electrons" leave the metal plate in a continuous process, *as waves,* whose frequency follows from the superposition of light waves and electron waves. Thus, according to equation (4), after the interaction no other frequencies (i.e. no other energies and velocities) are possible – wave superpositions do not permit other results.

This means: in the wave model it is obvious why the amplitude of the light and its intensity don't matter, and also why no delay occurs until the first measurement takes place: the superposition process starts immediately. The assumption of indivisible light particles can be dispensed with.

However the most important point is the following one, because here for the first time the core of the new interpretation becomes visible:

The equation
$$\nu_L = \nu_{e_0} \frac{v^2}{2c^2} \tag{6}$$

contains already the essential result: the square of the velocity of a free electron after the interaction depends only on the frequency of the light (in the case of a bound electron, on the left side the term $-\delta_\nu$ has to be inserted).

For the derivation of this equation, only two presuppositions are required:

1. Both light and electron are waves.

2. The Lorentz-Transformation applies.

Besides these two, *no other physical prerequisites* are needed.

Only after the multiplication by h, that is: at the step from (6') to (7):

$$h\nu_L = h\nu_{e_0} \frac{v^2}{2c^2} = m_e c^2 \frac{v^2}{2c^2} \tag{6'}$$

$$h\nu_L = \frac{m_e v^2}{2} \tag{7}$$

and for the physical interpretation of (7), the concepts *energy* and *mass* are required, as well as the relation between those concepts and the frequency

$$h\nu = mc^2 = E$$

With other words: For the description of the interaction between light and electron in the Photoelectric Effect the assumption is sufficient that both partners are waves. Not only the assumption of light quanta is superfluous, indeed *all* physical concepts and relations can be dispensed with. Only at the transition to a mechanical description of the usual kind, the concepts appear, which otherwise are the indispensable basis of the description: mass, kinetic energy, total energy.

Therefore, here the descriptions by waves and by particles are not at the same level. Instead they have a hierarchical relationship: The wave description comes first – it is *fundamental*, the particle description is subordinated – it is *derivative*.

Thus in this case the equations $E = h\nu$ and $p = h/\lambda$ do not prove the wave-particle dualism; they are **definition equations** of the quantities energy and momentum.

The concept *energy* is **reduced** to the concept *frequency*, and the concept *momentum* to the concept *wave-length*.[29]

It is obvious that, if this interpretation, which arises quite naturally at the Photoelectric Effect, is sustainable, then *formally* nothing changes, but conceptually *everything* changes.

Let us summarize. It has been demonstrated that the Photoelectric Effect can be described in two ways:

1. According to the mechanical impact model. Both interaction partners are understood as particles.

   Then either a *dualistic* position has to be taken (quanta which carry the whole energy are embedded in the waves – this was the point of view of Einstein, de Broglie and later of David Bohm), or *complementarity* has to be assumed (this is the so-called Copenhagen interpretation). The dualistic position leads to explicit non-locality, the Copenhagen interpretation leads to the relinquishment of any kind of understanding.

[29] However this reduction is only complete, if mass is eliminated as an independent concept, so that h loses its role as link between the wave- and the particle-realm. The decisive step was carried out in Chapter 4 on gravitation, where we replaced the mass defined by kilogram through the mass defined by meter.

2. By superposition of waves. Both interaction partners are understood as waves.

Concerning radiation, the interpretation difficulties connected with the positions mentioned in Point 1 disappear. Neither dualism nor complementarity need to be resorted to.

For the moment, all of that applies only to the Photoelectric Effect. The next step we must take at our branching off from the historical path of physics is testing our model assumptions at the scattering of high frequency light (X-rays) on electrons.

7.3. The Compton-Effect

At the scattering of X-rays on electrons, two effects are observed, which also do not seem to be in accordance with the assumption that light is only a wave.

1. The wave-length of the scattered radiation is greater than the wave-length of the incoming radiation.

2. The scattering angle distribution is asymmetrical with respect to the forward and backward direction.

In 1922, Arthur Compton described the scattering of X-rays on graphite as impact process of light-particles and electrons.

He derived the measured, on the scattering angle ϑ dependent difference between the wavelength λ_2 of the scattered and the wavelength λ_1 of the incoming radiation

$$\lambda_2 - \lambda_1 = \lambda_C\,(1 - \cos\vartheta) \qquad (\lambda_C \text{ Compton wave-length of the electron})$$

under the assumption that light particles are scattered on electron particles.

The difference between the Compton Effect and the Photoelectric Effect, seen from the conventional viewpoint, is that at PE the photon is absorbed, i.e. its total energy is passed to the electron, whereas at CE the photon is deflected and loses only a part of its energy.

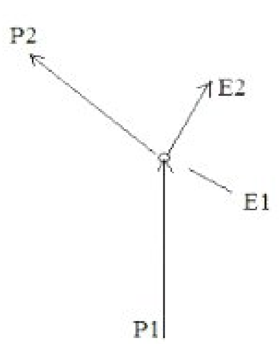
From our viewpoint, the difference between the two effects consists in the fact that at PE both waves form a persistent superposition, whereas at CE they separate again.

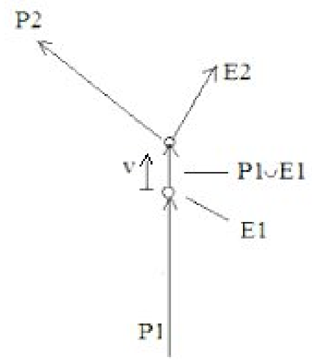
Therefore, seen in this way, the scattering process photon-electron proceeds in two steps:

A: The photon hits a resting electron. Both waves form a superposition.

B: The two waves separate again.

In the following outline, to the left the scattering seen as particle impact, to the right our two-step variant:





(S2)

$P1 \cup E1$ denotes the short-time state where both waves are united (superimposed).

Thus the whole process can be described as follows:

The resting electron E1 unites with the photon P1. Hence it turns into E_+. ($E_+ = P1 \cup E1$). E_+ moves with velocity v. E_+ emits the photon P2 and turns into the electron E2.

Let us denote the laboratory system as the reference frame S. Now let us look at the scattering process from a reference frame S', which moves with velocity v relative to S, and with respect to which E_+ is at rest. (Thus E1' moves with -v relative to S'.)

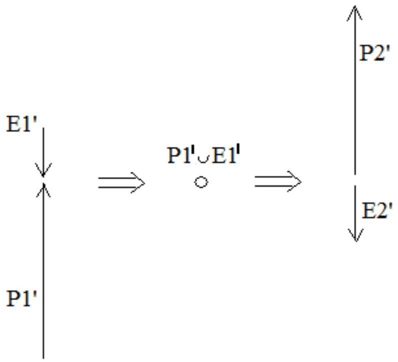
An electron moving at v possesses a de Broglie wave-length

$$\lambda_B = \lambda_C \frac{c}{v} k \qquad (\lambda_C \text{ ... Compton wave-length of the electron, } k = \sqrt{1-\frac{v^2}{c^2}}\ )$$

Therefore with respect to S' applies:

(1) The wave-length of E1' is $\lambda_C \frac{c}{v} k$.

We remain in S'. We look at first at the case where both waves separate exactly along the straight line on which P1' was moving towards E1' :



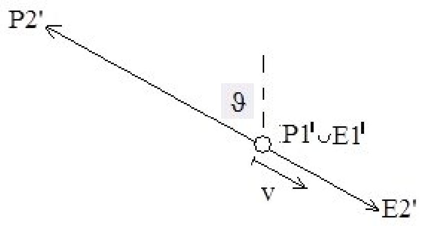
(S3)

Obviously, in this case the separation process SP(0°) represents the inverse of the uniting process UP, and this leads to

$$P2' = P1' \quad \text{and} \quad E2' = E1'.$$

Thus E2' moves with velocity -v with respect to S'. (exactly as E1' before); in the usual description, P2' would be just an *unscattered* photon.

Now we turn to an arbitrary separation direction ϑ . With respect to S', after the separation P2' and E2' again move away from each other along a straight line:



(S4)

Compared with the separation process SP(0°), the separation process SP(ϑ) is only *rotated*, but unchanged in any other respect. Thus it is the *same* process, and the absolute value of the velocity of E2' in S' is therefore again |v|, and the Photon originating from SP(ϑ) is – except for the direction – identical with the one that originates from SP(0°).

Combined with what has been said just before, it follows:

(2) With respect to S' holds: Except for the direction, the light waves P1' and P2' are identical.

Thus $\lambda_{P1'} = \lambda_{P2'}$ for all scattering angles ϑ.

At last we need the following:

In S', E1' moves with velocity -v. E_+ is at rest.

Now the question is: E_+ is the superposition state of the two waves P1' and E1'. If E_+ is at rest, what follows with respect to P1?

The de Broglie wave-length of the electron $\lambda_B = \lambda_C \frac{c}{v} k$ is a relativistic phenomenon: Due to the Lorentz transformation of an in-phase oscillation to a system moving with velocity v, the phase coincidence is canceled and a phase-wave with just this wave-length emerges. If the movement generated in this way should disappear, then this phase-shift must be annulled.

Let us look at the short-time superposition E_+ of the waves representing P1' and E1':

According to (1), E1' is represented by (f_e ... frequency of the resting electron)

$$\cos 2\pi \left(t\ f_e \frac{1}{k} + x \frac{1}{\lambda_C} \frac{v}{c} \frac{1}{k} \right) = \cos 2\pi \left(t\ f_e \frac{1}{k} + x \frac{1}{\lambda_B} \right)$$

P1' is represented by

$$\cos 2\pi \left(t\ f_{P1'} - x \frac{1}{\lambda_{P1'}} \right)$$

If we now set the wave-length of P1' equal to the one of E1':

$$\lambda_{P1'} = \lambda_B = \lambda_C \frac{c}{v} k$$

then, according to the identity

$$2 \cos a \cos b = \cos(a + b) + \cos(a - b)$$

we obtain, as the result of E1' $*$ P1', *two waves* (in the same way as in the Photoelectric Effect):

In the first wave, the x-term disappears, which means that the phase shift is in fact canceled and that, therefore, the velocity of E_+ is indeed equal to 0.

The second wave would move, seen from S, opposed to the direction of the incoming photon, but at the same time its frequency would be reduced compared to the frequency of the electron E1 that rests in S, which would be impossible. As in the Photo Effect, also here this second possibility is inapplicable.

Therefore we can state:

(3) With respect to the reference frame S', the incoming photon P1' has the wave-length

$$\lambda_{P1'} = \lambda_B = \lambda_C \frac{c}{v} k$$

Now we must just transform from S' back to the laboratory system S.

In order to calculate the wave-lengths of P1 and P2, we need the relativistic Doppler Effect with respect to an arbitrary angle ϑ, which has the following form:

$$\lambda' = \lambda \left(1 - \frac{v}{c} \cos\vartheta\right) \frac{1}{k}$$

In our case is
$$\lambda_{P1} = \lambda_{P1'} \left(1 - \frac{v}{c}\right) \frac{1}{k}$$

and, because of (2)
$$\lambda_{P2} = \lambda_{P1'} \left(1 - \frac{v}{c} \cos\vartheta\right) \frac{1}{k}$$

From this follows
$$\lambda_{P2} - \lambda_{P1} = \lambda_{P1'} \frac{1}{k} \frac{v}{c} (1 - \cos\vartheta)$$

If we now insert the value of $\lambda_{P1'}$ from (3), we get to

$$\lambda_{P2} - \lambda_{P1} = \lambda_C (1 - \cos\vartheta)$$

and this is the desired result.

What about the asymmetry of the distribution of the scattering angles?

In S', all scattering angles are equiprobable, which means: equally distributed between 0 and 2π. For the laboratory system S follows then the observed, with the frequency of the incoming photons increasing asymmetry of the distribution of the scattering angles.

Thus also in the description of the scattering of high frequency light on electrons it was possible, without any physical resources and prerequisites, only based on the assumption that both light and electron are waves, to derive the correct result. Since this result is given here in the form of a wave-length difference, it was – other than at the Photo Effect – never necessary to change over to the usual "mechanical" description. We did not even need to mention the concepts energy and mass.

As could be seen, symmetry assumptions were applied. However they did not serve, as usual, for substantiating conservation laws, but for the assumption that, with respect to S', only the propagation direction of the two waves changes after they have separated, whereas in every other respect they remain identical.

Everything which was said at the end of the previous section, applies identically or analogously also here. Therefore, a summary or commentary is superfluous.

Thus we have described the two experiments, by which the wave-particle dualism was brought into physics, solely by wave superpositions. The assumption of light particles could be dispensed with.

The next step will be to generalize the explanation pf the double-slit experiment – with other words: to analyze the quantum mechanical measuring process and, in this way, to eliminate the dualism of matter. This purpose seems to be precluded by the fact that this dualism represents downright the basis of the quantum mechanical formalism and its interpretation.

7.4. The Measuring Process

"Unter den [...] Gegnern der "orthodoxen" Quantentheorie nimmt Schrödinger insofern eine gewisse Ausnahmestellung ein, als er nicht den Teilchen, sondern den Wellen die "objektive Realität" zusprechen will und nicht bereit ist, die Wellen nur als Wahrscheinlichkeitswellen zu interpretieren. [...] Freilich kann Schrödinger [...] nicht das Element von Diskontinuität aus der Welt schaffen, das sich in der Atomphysik überall [...] äußert. In der üblichen Deutung der Quantentheorie ist es an der Stelle enthalten, wo jeweils der Übergang vom Möglichen zum Faktischen vollzogen wird. Schrödinger selbst macht keinen Gegenvorschlag, wie er sich etwa die Einführung des überall zu beobachtenden Elements von Diskontinuität anders als in der üblichen Deutung vorstellen will."[30]

[30] Werner Heisenberg, Phys. Bl. 12 (1956), S. 300.

("Among the objectors of 'orthodox' quantum theory, Schrödinger takes insofar a certain special position, as he wants to assign not to the particles but to the waves the 'objective reality' and is not willing to interpret the waves just as probability waves. However, Schrödinger is not able to eliminate the element of discontinuity that appears everywhere in atomic physics. In the usual interpretation of quantum theory, it is incorporated at that position where the respective transition from possibility to reality occurs. Schrödinger himself presents no counter-proposal how he would imagine the introduction of the everywhere observable element of discontinuity other than in the usual interpretation.")

To date, there is no reasonable proposal as to how “the transition from the possible to the factual” occurs during measurement. In our description of the double slit experiment, it is explained simply by addition of waves and the resulting transition from one standing wave state to the next higher state – a completely self-evident fact with standing waves.

At the same time, the “element of discontinuity that can be observed everywhere” is explained in a clear way, and quite obviously also “differently than in the usual interpretation”, i.e. not by assuming an entity called “particle”.

In order to relate this "transition from the possible to the factual" – the so-called "reduction of the wave function" that takes place during the measurement process – to the quantum mechanical description scheme, we will now take a short excursion into the formal part of quantum theory.

Let $\Psi(x)$ be the state vector of an object T. An attribute of T is to be measured that corresponds to the operator A.

Let be $A\Psi(x) = \sum_{i=1}^{n} s_i U_i(x)$ (U_i eigenfunctions, s_i coefficients)

Let a_i be eigenvalues of the corresponding U_i. Then the result of the measurement will be one of the a_i.

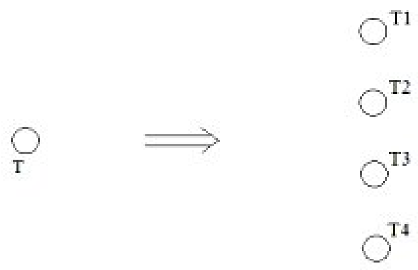
So much to the quantum mechanical specifications, the validity of which is verified to such an extent that they can be considered facts. But now the area of interpretation begins:

If the value a_j ($1 \leq j \leq n$) is measured, then T – i.e. *the very same object* that has been represented before by $\sum_{i=1}^{n} s_i U_i(x)$ – is supposed to be in the state U_j: the whole sum $\sum_{i=1}^{n} s_i U_i(x)$ has been reduced to the one term $s_j U_j$.

Let us call this hypothesis (H1). It is the fundament of the contemporary interpretation of quantum mechanics:

(H1) *The state function after the measurement, which is reduced to one single term, represents* ***the same object*** *as the state function before the measurement. The one term corresponds to the state of this object after the reduction.*

A simple illustration:



(S5)

T is the object, on which the attribute A is to be measured. T1, T2, T3 and T4 represent 4 different possible states of T after the measurement. If j = 3, then T3 becomes the measured reality. T1, T2 and T4 disappear.

Thus hypothesis (H1) says:

T3 is the same object as T. T is the state of the object ***before*** the measurement, T3 is the state of the object ***after*** the measurement.

In contrast, the model presented here is based on the following hypothesis (H2):

(H2) *The object that after the measurement is in the state* U_j *is* ***not the same object*** *as the one which was represented by* $\Psi(x)$ *before the measurement. None of the eigenfunctions* U_i *with* $i \neq j$ *that belong to the representation of the object* T *disappears; instead they will all contribute to subsequent measurements, where other, with* T *formally identical objects (e.g. electrons) will be measured. Thus there is no "reduction", at least not in the sense that anything disappears.*

(H2) means:

1. *A part* of T – the one, to which T has been "reduced" according to (H1) – contributes to the *actual* measurement result, i.e. to the value of the attribute A, *all other parts* of T contribute to *other, future* measurement results.

2. In general, the measurement result is caused not only by waves of T but also by waves that stem from other objects which are formally identical with T .

Thus in the scheme depicted in (S5) applies – in contrast to the usual interpretation:

T3 is *not* the same object as T. On the one hand, T3 contains not only waves of T, and, on the other hand, T contains also waves which do not contribute to the event T3, but to (possible) future events T1, T2 and T4.

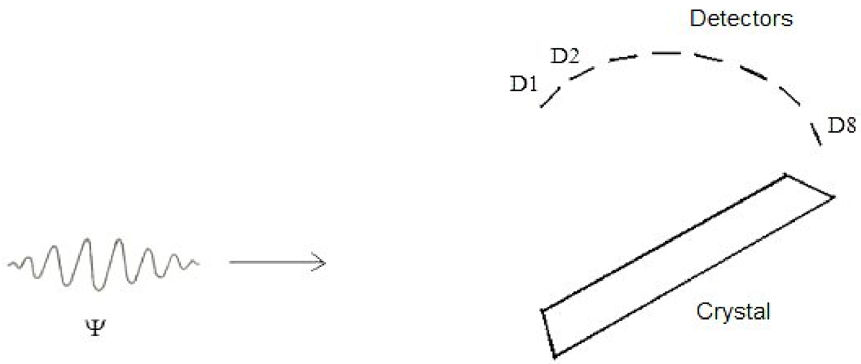
This can be illustrated by the following example:

Let T be an electron. The momentum of T is first to be calculated and then to be measured.

To determine the probability distribution of the measurement values, the momentum operator must be applied to the wave function Ψ which represents T. This procedure is a *spectral analysis:*

Ψ is split into sine waves with different wave-lengths, and the according amplitudes are determined. Their squares give the desired probabilities.

In the experiment, the wave-packet must *actually* be split. This splitting could be carried out e.g. by the following arrangement:



(S6)

The wave packet Ψ is dispersed at a crystal, which means that the waves with different wave lengths contained in Ψ are diffracted at the crystal surface. This surface acts as a plain diffraction grid which decomposes the wave packet into virtually monochromatic radiation bundles.

Near the crystal surface all waves interfere, yet at a sufficient distance the rays separate, such that all waves that arrive at a certain detector have a (nearly) identical wave length. So we have sorted the wave packet by wave-lengths (momentums).

Thus the *formal* division by the application of the momentum operator corresponds to the *real* division of the wave packet into sine waves with different wave-lengths by the experimental setup.

According to the usual interpretation, the measurement has the effect that one of the eigenfunctions of the momentum operator leads to the measurement result, that is: it becomes *real,* whereas the others *disappear.* In one detector we now have an electron with a certain momentum – which did *not* exist before –, in the other detectors we have *nothing*.

In the interpretation proposed here, there is no reduction. None of the eigenfunctions disappears. All eigenfunctions will contribute to future events (measurements). The amplitude squares of waves with a certain wave-length add up in the respective detector, until a transition occurs – a momentum measurement has been carried out (which in general is again not the consequence of a single wave-packet but requires the adding-up of amplitude squares of many wave packets that had arrived earlier).

Also here it can be seen clearly that quantitatively nothing changes. The wave packets are divided into sine waves with different wave-lengths, which arrive at the corresponding detectors. If now, according to our basic assumption, the characteristic re-organization of a local spatial oscillation state – i.e. the appearance of an electron – is *caused* by the adding up of wave intensities, then the probability of the events in a certain detector must depend on the amplitude square of the waves that *actually* hit this detector – exactly as predicted by quantum mechanics.

Doesn't it somehow *contradict* the QT formalism to assume that a particle develops somewhere and later *the same* particle appears again – even if formally (*and* experimentally) a partition takes place and the parts are displaced arbitrarily far from each other? It would not be totally absurd to call this an interpretation *against the formalism*.

In contrast, my proposal keeps close to the quantum mechanical formalism and permits connecting the concepts of the formalism with a local reality:

If a particle X is generated at a certain position *before* the measurement, and *after* the measurement an identical particle appears at another position, then this is not *the same* particle; the waves originating from the decomposition of the characteristic oscillation pattern X split up according to their formal description – they *actually* diverge – and contribute to the development of another oscillation pattern X, which however deserves to carry the same identifier X not because it is *substantially* but only *formally* identical with the first one.

7.5. Die Central Assumption of the Local and Objective Interpretation

The objective and local interpretation of quantum mechanics is based on one single assumption.

It reads as follows:

If event probabilities can be determined by a quantum mechanical wave function, then there is an ***actually existing wave*** *that* ***causes*** *these events.*

Accordingly, quantum mechanical amplitude squares are not just formal tools: they represent probabilities only because they correspond to intensities of real waves.[31]

[31] What about the probability amplitudes of events that will *not* occur? (E.g. the state of a radioactive nucleus is a superposition of the states *decomposed* and *not decomposed.*) The answer is: If amplitude

From this follows immediately that there is ***no reduction of the wave function:*** What exists cannot disappear.

Since in wave functions of particles moving outside of matter the waves generally diverge, a realistic interpretation is equivalent to abandoning the particle concept in the usual form.

In is replaced by a different particle concept, which is defined as follows:

The phenomena that are usually referred to as "particles" are stationary states of waves – in the simplest case standing waves or oscillation areas of standing waves separated by nodal surfaces – or transitions between such states.

Outside these states there are only traveling waves or diverging wave groups; the term “particle” then loses its meaning.

Since the identity of the "particle" initially created by a transition and the "particle" ultimately measured by a transition is now abolished, the assertion of its existence between generation and measurement is misleading.

Waves *and* particles – or let’s say objects – only exist in the realm of phenomena. The fundamental, causal level of reality is wave-like.

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squares are defined as probabilities, then the introduction of amplitude squares is necessitated, which represent the complementary probabilities. It is this formal act of completion to which those – in this sense – "complementary" amplitudes owe their existence. Still, it can be stated that they relate to real waves, however only via this formal intermediate step..

7.6. Interpretation of the Formalism

The program of this book is to establish the description of reality upon a purely metric basis.

Since equations (0) and (1), which represent the creation of reality, only contain metric facts, everything that can be derived from them is also purely metric in nature. This also applies to the waves that we derived in Chapter 3 and which we assume to be of fundamental importance for the creation of reality.

I repeat this here because the existence and success of quantum theory can be seen as justification for this program. As it turns out, the following can be said with good reason:

Quantum theory is precisely the theory that makes it possible to describe the foundation of reality, which consists exclusively of waves, by means of concepts that stem from the tangible world of objects. It forms the connection – the “interface”, so to speak – of these two realms.

The argumentation that is necessary for substantiating this claim will then also serve to justify the formalism and make it understandable.

We will first start with an example – the historically first and still most popular case of uncertainty: that of position and momentum –, then generalize the principle recognizable from it and transfer it to the quantum mechanical formalism.

Every object has a position and a velocity at every moment – at least as long as you imagine an object as something that occupies a well-defined volume of space at every moment.

Physics before the 20th century was based on exactly this idea, and that is why there was great surprise when it turned out that it was impossible to precisely determine both position and velocity at the same time for very small objects.

Initially this was justified by limitations of measurement, but over time it became clear that it is a limitation that applies to nature itself.

At this point it was already known that objects on atomic scales could be described by the matter waves discovered by de Broglie, and that energy and momentum of such objects are determined by the equations

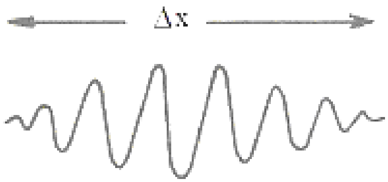
$$E = h\nu \quad \text{and} \quad p = h * 1/\lambda$$

This means that actually all the prerequisites were in place that were needed to establish the connection between the two worlds: between the abstract causal metric world of waves and the concrete, tangible world of objects that physics had dealt with up to that point:[32]

Firstly, the *type* of wave (or wave class) by which energy and momentum are defined was known: matter waves are *sine waves* – and secondly, there was a bijective relation between the values of the wave properties frequency and wavelength and the values of the associated object properties energy and momentum.

Unfortunately, none of the physicists was able to interpret this connection correctly – except Schrödinger, whose attempt, however – as mentioned previously – failed due to his wrong idea of particles. If someone had recognized that electrons or other objects in this order of magnitude could not only be *represented* by wave groups made up of matter waves, but that they actually ***are*** such wave groups, then it would not have been confusing at all, but rather self-evident that an "uncertainty principle" applies for the quantities position and momentum.

According to our realistic view, this is simply the case because to spatially limited wave trains (wave packets) like in the following sketch



(S7)

[32] Einstein had already made this connection in the area of gravity, but without the metric justification context that we presented in Chapter 4.

always an "uncertainty relation" of the form

$$\Delta x * \Delta(1/\lambda) \geq 1$$

applies. Such wave trains just *do not possess* a definite wave length. Instead, they are composed of waves with different wave-lengths. The smaller the spatial extension is, the greater is the interval of the required wave-lengths. Reversely, the more exact the wave-length is – and, in our case, at the same time the velocity – the greater is the uncertainty of the position Δx.

If this fact is connected with the equation

$$p = h * 1/\lambda$$

then follows

$$\Delta x * \Delta p \geq h .$$

Of course this has already been said often enough. Nonetheless it had to be mentioned here again, because in the usual interpretation of quantum mechanics, it must be seen as a purely formal fact and not as an explanation. It can only turn into an explanation if it is assumed that particles *are* stationary wave states and that, accordingly, momentum is *defined* by wave-length.

Therefore to the quantities momentum and position the following applies:

1. Both quantities are *defined* as wave properties, and they correspond to certain *types* of waves: sine waves are assigned to momentum, and to position pulse waves (i.e. waves, whose amplitude is only in one point not equal to zero).

2. The prerequisite for the assignment is that there is a bijective relation between the wave property (wavelength or amplitude) and the assigned object property (momentum or position). This condition is fulfilled here.

3. To the values of the two object properties applies an uncertainty relation. *This uncertainty is a purely wave-mathematical fact* (more on this later). It is transferred to the two object properties through their definition.

As regards position and momentum, everything that seemed strange from the conventional viewpoint has disappeared. While, in the usual interpretation, it seems outright absurd that a particle should not possess exact values of position and momentum at the same time, in the alternative interpretation – where objects (wave packets) simply *do not have* a definite spatial volume – it is just an evident fact.

The question is: *Can this scheme be transferred to all physical object attributes ?*

The answer is *yes*. Strictly speaking, nothing at all has to be transferred – quantum mechanics ***is*** exactly this scheme. Thus what has to be done is just re-interpreting the formalism.

Let us look at the quantum mechanical scheme in its simplest form:

Quantities to be measured are observables. They are assigned to operators. By applying an operator to the vector in Hilbert space, by which the state of the object to be measured is represented, this vector is decomposed into a series of eigenfunctions, i.e. a *spectral analysis* is carried out: eigenfunctions are waves whose form depends on the kind of the operator.

(E.g. de Broglie matter waves are eigenfunctions of the momentum operator, spherical harmonics – i.e. standing waves on the surface of a sphere – are eigenfunctions of the angular momentum operator.)

Therefore, assigning observables to operators is tantamount to assigning them to *wave-categories*.

However in any set of wave categories, in which a wave superposition can be decomposed, there are pairs of categories to which – in the same way as to sine waves and pulse waves – an *uncertainty relation* applies. [33] Thus this must also be true at the spectral decomposition of the state vector. And this uncertainty is again transferred to the physical quantities *defined* by these wave categories.[34]

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33 At a division in two such classes of waves, the product of the bandwidths cannot be smaller than 1.

34 I emphasize again: since there are only waves, all causal connections must be traced back to waves. Therefore, the assignment of the properties of objects to wave classes is a necessary act that occurred in physics precisely at the time when it had advanced to scales at which the fundamental wave nature of reality was revealed.

So how is this formal scheme to be interpreted?

The most important elements of the interpretation have already been described and explained. Here is a short summary:

The object that emerges as a consequence of the measurement is *not* the same object as the one to be measured; the object to be measured is (in general) a wave group, the partial waves of which will contribute to various measuring events. (See the scheme in 7.4.)

The state vector represents the object to be measured. Thus it relates to the wave packet *before* measurement, and accordingly the spectral analysis relates to the decomposition of this wave packet into waves, which belong to the category to which the attribute to be measured is assigned.

Since the wave category in which the state vector is decomposed is freely selectable, the vector contains all measurable attributes *as possibilities* – however not in the Heisenberg sense as another kind of existence but in a completely ordinary sense: each of the waves contained in the wave packet, which belong to any wave category, can contribute to the formation of an object, i.e. of the object of the actual measurement or an object of subsequent measurements.

At an experiment, it is (in most cases) necessary to *actually* decompose the wave packet, as was explained with the example at the end of 7.4. The distribution of the measured values will then, as elucidated in this example, correspond to the distribution of the amplitude squares of the waves contained in the state vector.

The measured object – the carrier of the measured variables – is in any case, provided it is an object of atomic or molecular magnitude, a *newly formed object,* which owes its existence to the measuring process.

Only through this *new-formation* of the measurement objects can the waves that the state vector contains become measured attributes, in other words: can possibility become reality.

It can be seen how some of the well-known formulations can be transferred to the realistic interpretation in a completely identical way – only their meaning changes: statements that point to the impossibility of forming a concept of what is going on become statements about a comprehensible reality.

Of course, in every case of assigning an attribute to a wave class, it must be possible to explain the physical reason for this assignment.

In the case of energy and momentum, most of this explanation has already been accomplished. Here is a short recapitulation:

In the chapter on relativity, motion (velocity) of objects was defined by *superposition of waves*, changing velocity by *altering frequencies*. Matter waves were generated by Lorentz transformation of standing sine waves. In this way, the conceptual basis for the definition of energy and momentum is formed, and it can be understood why energy is assigned to the (non-directional) quantity frequency of matter waves, and momentum to the (directional) quantity wavelength of matter waves.

Formally. these definitions were demonstrated and confirmed in the description of the photo-effect (7.2) and Compton effect (7.3).

Why spin and angular momentum are assigned to spherical surface functions (standing waves on spherical surfaces) on atomic and molecular scales is explained in Chapter 9, starting with the spin.

So some of the most important assignments have already been traced back to understandable facts.

In short:

Quantum theory does not simply unite the wave- and particle-like attributes of objects of the basic layer of reality. Rather it is the theory where the fundamental metric world of waves and the object-world built from them meet one another.

Therefore it is also clear that quantum theory is unavoidable: all physical descriptions – as abstract as they may be – ultimately serve to explain tangible facts that can be experienced..

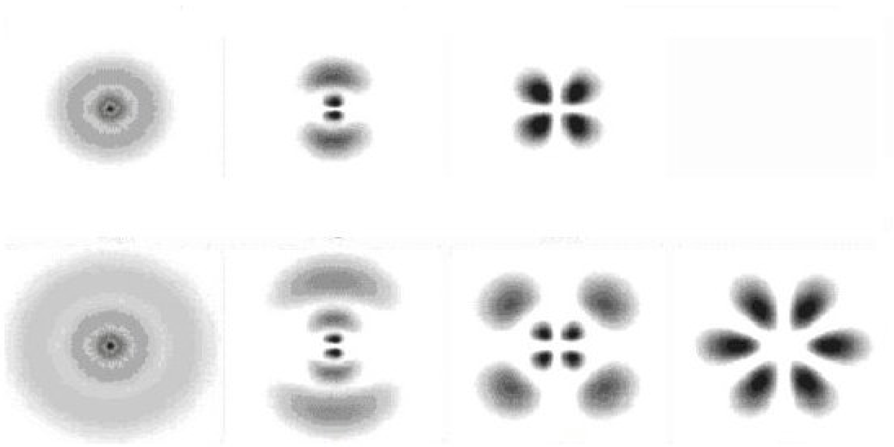
I repeat the statement made at the beginning of 7.6, which is now sufficiently justified by our argument:

Quantum theory is precisely the theory that makes it possible to describe the foundation of reality, which consists exclusively of waves, by means of concepts that stem from the tangible world of objects. It forms the connection – the "interface", so to speak – of these two realms.

As has been shown, the epistemological confusion that has lasted more than 100 years and continues to the present is not rooted in the quantum mechanical formalism itself, but in its interpretation: only the inability to detach oneself from objective thought patterns creates paradoxes and leads to a total loss of all understanding of reality.

7.7. Final Review

Here again the pictures of the electron shells. In the standard interpretation, the structures depicted are referred to as "density distributions", i.e. the square of the amplitude of the wave gives the probability that an electron is there. (Just as with the running wave after the double slit.)



We can now either claim that these wave functions are nothing but mathematical tools for determining the probability of the (point-like?) electron's position -- with all the well-known absurd consequences, or we accept what is actually evident: that all of these images refer to states of really existing waves. Then all absurdities disappear and the circumstances become clear.[35]

[35] In my book *The Concept of Reality*, starting on page 142, the local and realistic interpretation of quantum theory is applied to several experiments. A number of the well-known “paradoxes” can be explained in this way.

Ever since I found my explanation of the double slit experiment, I have been concerned with the question of why this explanation – which I thought from the first moment to be so simple and self-evident that it seemed almost inevitable to me – had not yet existed. In my view, the difficulties that stand in its way are far preferable to the absurdities of the usual interpretations![36]

I believe that the reason for its absence lies primarily in the way physics has developed. Newtonian physics was based almost entirely on the idea of particles interacting with each other. This idea was so dominant that Christiaan Huygens, for example, had great difficulties in asserting his proof of the wave nature of light.

When wave mathematics finally established itself alongside particle mathematics on an equal footing, problems were encountered when describing the interaction between waves (light) and particles (electrons). The solutions that Einstein and Compton found then led to the so-called wave-particle dualism, which forms the basis of the current interpretation.[37]

Therefore, the idea of physics without particles is hard to imagine. In fact, however, the concept particle is completely vague. Its only two clear characteristics are *discreteness* and *spatial limitation* of events – but these are precisely the properties of standing waves and the transitions between their states. (Measuring events are always such transitions!)

Ultimately, it is probably our everyday experience of the world that suggests the particle idea to us. We live in a world of objects that predominantly present themselves to us as solid bodies. So the first path to abstraction almost inevitably leads to the assumption of "particles" as basis of reality.

The usual way of presenting the double slit experiment is also completely under the spell of this suggestion. The model idea: "An electron particle breaks away from an atom or molecule, crosses a double slit, behaves in a wave-like manner and finally appears again as a particle on a detector

[36] For example, the question of why never several electrons appear at the same time. This is obviously not a fundamental ontological problem, but simply a problem of correctly modeling the order of events. It can be explained through exchange processes between the standing electron waves – but only on the basis of *ad hoc* assumptions, which is why I have omitted it here. (In *The Concept of Reality*, starting p.123 below, I have made some comments about these processes.)

[37] As we have shown, with both the photoelectric and the Compton effect, the elimination of "particles" is not only possible without loss, but is even *necessary* for obtaining comprehensible explanations and leaving behind the absurdities of the standard interpretation.

plate" basically corresponds to the idea of throwing a ball: "Person A throws a ball, the ball flies for a while, finally Person B catches it" – of course apart from the fact that, unlike the electron, the ball always remains a ball and does not temporarily change into a wave-like state along the way, which is the inexplicable part of the description.

From the point of view taken here, this model is completely unsuitable:

Even the understanding of the electron as an "object" is problematic: is the oscillation area of a standing wave that lies between two nodal surfaces an object? It may seem somehow justified or at least understandable to regard it as an object, and the same applies to the wave that diverges after the double slit, which then represents the "electron".

But it is completely wrong to assume that **the detected electron** is in any sense **the same electron** as the one that was created just before.

(In the ball throwing analogy, this would mean: the ball caught is not the ball thrown.)

The advantage of the scenario just presented is obviously that it is completely free of all the absurdities that are inevitable both in the standard interpretation and in all alternative variants.

However, Bell's proof of non-locality seems to stand in the way of a realistic and local interpretation. In the next chapter we will show that this proof is no longer feasible if the explanation scheme of the double slit experiment is applied to the so-called Einstein-Podolski-Rosen scenario.

The "electron shell" model on which my explanation is based, is of course only an approximation and also incomplete: It is an *approximation* because the above images are solutions to the Schrödinger equation for one-electron atoms, so that adjustments must be made for multiple electrons, and it is *incomplete* because two important elements of the quantum mechanical representation are missing: orbital angular momentum and spin.

In Chapter 9 we will carry out a metric-dynamic reconstruction of the quantum mechanical atom model. The orbital angular momentum can be supplemented with the help of the idea that the spherical waves shown in the sketch are set in rotation. Justifying the spin requires a slightly more complex analysis.

For a completely realistic interpretation of what happens in the double slit experiment, also the following questions must be clarified:

What oscillates in electron waves? And also: *What oscillates in "photons"?* Furthermore: *What do light waves and electron waves have in common and what differentiates them?*

These questions are answered in Chapter 9. It will be shown that the metric-dynamic structure of the quantum mechanical atom model requires the assumption that electrons are *waves of the metric density of the angle*, which we derived in Chapter 3.

Finally, the following should be pointed out: In all representations of quantum mechanical measurement processes in this chapter, it has been explained how and why the measurement event occurs. What is missing, however, is a detailed description of the course of the measurement series that corresponds to the course actually observed.

Although it is not too difficult to simulate this process on the computer, this simulation requires additional assumptions – exchange processes between the local standing waves – which owe their existence basically to the purpose of achieving agreement with reality. In my view, that makes them unattractive. That's why I didn't represent such simulations here. I believe that the path to a detailed description of quantum mechanical measurement series only makes sense with experimental support.

Remark:

My comments on quantum theory are all about changing the interpretation. The formalism itself remains untouched.

However, I consider it a serious mistake to ignore interpretation problems: interpretation contributes significantly to determining future goals of physical research, and the interpretation proposed here gives rise to the assumption that the long-overdue overcoming of the so-called "Standard Model" of particle physics has so far failed to a certain extent due to the conviction that the further development of physics is based primarily on the discovery of new "particles".

To name just one aspect: the assumption of particles obscures the obvious fact that when assuming waves, at some scale there must be a limit for the linearity of the representation – and that means: for quantum theory in its current form. I suspect that this is the case in the atomic nucleus.

In this area, described by the strong interaction theory, the oddities of the standard interpretation are particularly evident. E.g. as follows:

Quarks are subject to the so-called "strong force". This "force" does not decrease with distance.

Therefore quarks cannot be separated from each other.

Neutrons consist of three quarks. In a neutron interferometer, a neutron beam is split into two beams through scattering at a crystal layer, so that the two beams are separated from each other up to a distance of a few centimeters. Then they are brought together again through scattering at a second layer, so that – after a third layer – interference can be observed.

The intensity of the neutron beam is chosen so low that with high probability in the interferometer there is only *one* neutron at a time.

This means: *single neutrons are divided*.

So the question arises:

If the neutron is divided – where are the quarks?

Because of the interference, there can be no doubt that *in both beams* "something" must be on its way, and then the question of where the quarks are is obviously unanswerable.

This contradiction can only be avoided in two ways: either by simply not asking, or let's say: not thinking, or by replacing the Standard Model of particle physics with a better theory.

From the perspective of our local and realistic interpretation, this contradiction proves that the theory of the strong interaction – and thus the whole Standard Model – is merely a quantitative approximation that does not contain the actual causal relationships.

8. Quantum Theory → Local Interpretation

8.1 Refutation of Bell's Proof of Non-Locality

Bell's proof (John Stewart Bell, *On the Einstein Podolsky Rosen Paradox*, Physics, 1, 195-200, 1964) relates to the so-called EPR-Paradox, named after the three authors (*Can quantum-mechanical description of physical reality be considered complete?* Phys. Rev. 47, 777, 1935).

To understand the paradox, a few facts will suffice:

(1) Generally, the quantum mechanical description of an object determines for some attributes not a definite value but only the probability distribution of possible measurement values.

(2) This applies also to the case of two spatially separated objects which interacted in the past or which originate from the decay of an object.

(3) Between the outcomes of certain measurements on these two objects there will then be a connection that is called "entanglement". E.g. in the case of two identical particles A and B which come from the decay of an object at rest and depart into opposite directions, the two momentums are interconnected in the same way as in classical physics, which means they are identical except for the sign. Another example: If a spin 0 system decays into two photons, then the measured polarization directions of the photons are rectangular to each other.

That's all there is to it! What is paradoxical about it? This is quickly explained, too:

Let us assume as yet no measurement has been performed. Thus only the probability distribution of the measurement values is known. But if now the momentum of particle A is measured, then, because of (3), *at the same moment* also the momentum of B is known, and the same applies to the case of the photon polarizations.

Now one can argue with Einstein, Podolsky and Rosen in the following way:

B is at an arbitrarily great distance from A. Therefore, the measurement on A cannot have influenced B. Thus we can state: if B has a definite momentum *after* the measurement on A, then it must have had this momentum also already *before* the measurement on A – otherwise the measurement on A would have caused a change of the state of B. However, since the quantum mechanical description does not contain this momentum, it must be considered *incomplete*. (In this case, the momentum would be a so-called *hidden parameter.*)

That sounds like a reasonable argument! Indeed the alternative would be to assume a *nonlocal connection* between the two measurements, that is a connection which requires either a faster-than-light transmission[38] or which exists without any mediating process at all and must simply be accepted as such.

However, as John Bell showed almost 30 years later (John Stewart Bell, *On the Einstein Podolsky Rosen Paradox*, Physics, 1, 195-200, 1964), this apparently so reasonable EPR assumption – that the measurement result on B is determined already before the measurement on A, because it simply corresponds to an *attribute* of B – has a consequence that Einstein, Podolsky and Rosen had not expected.

Bell proved the following:

Provided that the EPR assumption is correct, there are experiments in which the measurement results deviate significantly from the predictions of quantum mechanics.

Such experiments were carried out. The decision was clear: the predictions of quantum mechanics were confirmed, the EPR assumption was thus refuted. This means: *Before* the measurement on A, B has no definite momentum, *afterwards* it does have one. The measurement on A actually changed the state of B!

EPR had intended to argue for a *local reality,* i.e. for a reality in which an object cannot act on another, spatially distant object other than through a physical process. However Bell's intervention seems to have proven that there are also connections of a completely different kind: connections which are either mediated faster than light or which even exist without any mediation. Einstein called that "Spooky action at a distance".

John Bell formulated his proof as general as possible. In this generalized form of the proof, it is not necessary that "object properties" specify the measurement result in advance, instead it could be any parameters. In Bell's own words: "Let this more complete specification be effected by means of

[38] Transmission by a process whose speed is not greater than that of light has been experimentally ruled out.

parameters λ. It is a matter of indifference in the following whether λ denotes a single variable or a set, or even a set of functions, and whether the variables are discrete or continuous." (John Bell, lc, p. 196). This generalization expands the scope of the proof. And since, apart from the assumption of the parameters λ (and of course logic and mathematics), no further assumptions are necessary for the proof, the following conclusion seems unavoidable:

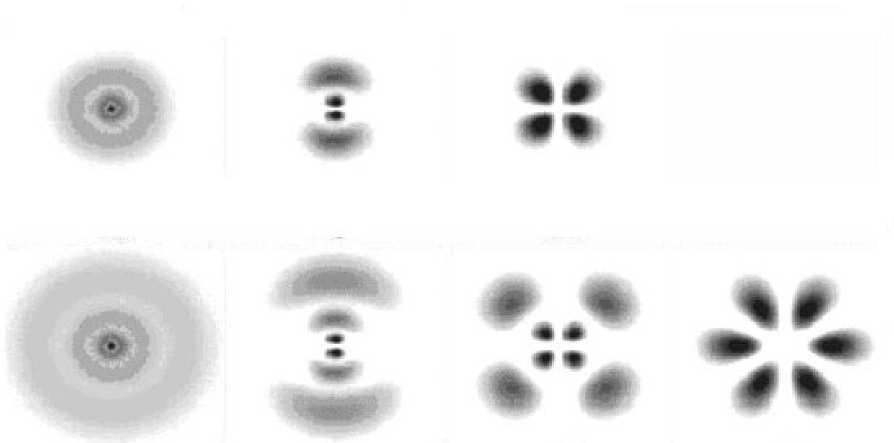
Any reality that obeys the laws of quantum mechanics is non-local.

So much for the situation. In physics, the question of locality or non-locality is considered to be settled, and entanglement is a much-noticed, active area of research. For us, however, the presentation of the usual point of view is only intended to serve as a preparation for our actual task, the answer to the question:

Why does Bell's proof not apply to our reality?

To answer this question, we need the model which was developed in the previous chapter. It allows a *realistic and local interpretation* of the double-slit experiment, which can be transferred to the EPR scenario. So I will briefly outline what, according to this interpretation, actually happens there.

First, an electron detaches from an orbital (an electron shell). Here are again the pictures of some orbitals:



As can be seen,*"electron shells"* correspond to *oscillation states of a sphere,* in other words: they are *three-dimensional standing waves.* If an "electron" is released from such a standing wave, then (so to speak) part of the *standing wave* becomes a *running wave.* The remaining standing wave has one nodal surface less. The electron – the running electron wave – then crosses the double slit. After the double slit, it diverges and interferes with itself. Finally it arrives at the detector plate, and this means: wherever its amplitude is not zero, it hits an orbital – a standing electron wave. Since it must be assumed that several of these standing waves are already close to the limit above which they "jump" to the next higher state – the state with one more nodal surface – the running wave will somewhere trigger such a jump with a certain probability, in other words: at this point an "electron" appears.

The rest of the running electron wave does not disappear as in the standard interpretation, but adds up to the other standing electron waves, whereby the probability increases everywhere that the next incoming electron wave or any subsequent one will cause a jump.

In order to establish the connection with the EPR scenario, let us consider the "object" we have just described, i.e. the "electron".

Let us first ask: *Does this electron have a definite position?*

To the electron that we finally observed on the detector plate, undoubtedly a relatively precisely defined position can be ascribed. But as we know, *this* electron is not *that* electron that was underway before. The newly created oscillation area in the standing electron wave, which in our view *is* the observed electron, contains only a tiny fraction of the entire running wave that the electron was before. The rest of the running wave is now distributed over all other standing waves.

So it is very clear: *The electron that we observe did not have a definite position before the measurement, because before the measurement this "electron" did not even exist!*

From this follows that the model concept which Einstein, Podolsky and Rosen's argument is based on, is completely inappropriate. They thought of an object that always remains identical with itself and moves on a path so that it has a definite position at all times.

It is therefore evident:

The EPR assumption that the object attribute already exists before the measurement is wrong.

If Bell's parameter λ referred to the value of this attribute – in the way it was meant by EPR – then the proof would already be refuted. Becaus of Bell's generalization, however, further analysis is required.

As can be seen from the above quotation, Bell assumes the existence of parameters λ which provide the "more complete" specification of the measured values for any measurements on the selected objects. ("More complete" because in quantum mechanics they do not exist or are "uncertain"). The existence of the parameters λ ensures that we can predict the exact measurement result in any case.

At the center of Bell's proof is an inequality that contains both the results of measurements that can actually be carried out, and the results of further, hypothetical measurements on the same objects. ("Hypothetical" because the measurement objects are of course not available again.)

This means:

The knowledge what results further measurements on the same objects would lead to is necessary for establishing the proof. Without this knowledge, there is no Bell proof.

Let us now return to our model. Is it possible here to predict the results of further measurements on the same objects?

Suppose we have created an electron. It crosses the double slit, diverges and interferes with itself. A tiny part of the running electron wave induces a standing electron wave on the surface of the detector plate to jump to the next higher state. A black point can be seen there, indicating that an electron has appeared. We have measured the position of this electron.

Can we now carry out another measurement with the electron that we have generated just before? (It is *not* the one whose position we have just measured!) Of course not – this "electron" no longer exists because it is now distributed over all orbitals – but we can generate an electron that is almost identical to the one previously generated, and that is sufficient for our train of thought: We cannot carry out another measurement on the same object, but we can repeat the measurement process.

Now to the crucial question: what will happen when *this* electron reaches the detector plate? At which position on the detector plate will an electron appear?

The answer is: we cannot know. The position of the next jump – i.e. the next appearance of an electron – depends not only on the amplitude distribution of the wave that hits the plate, but also on how far the standing electron waves on the plate are away from the jump to the next state, and that is constantly changing. There is no measuring process in which, for all electron waves, the distances from this jump limit are equal to the distances that they have in any other measuring process.

("Distance" is defined here by how large the amplitude square of the impinging electron wave must be at least in order to trigger a jump to the next higher state).

In other words:

It is impossible to predict the exact position of the appearance of any electron.

What we have just shown for a position measurement in the double slit experiment also applies to the measurements of the attributes of entangled objects in EPR scenarios.

Let us consider, for example, the case that has been best investigated experimentally: polarization measurements on entangled photons.

First the usual description: Photons are generated in pairs. On their way they reach polarizers which they cross with a certain probability. If they get through, they hit a detector and a photon is registered. If they don't get through, no photon will appear.

Now to the explanation of what is really happening. It follows the same principle as in the double slit scenario: Photons *are* light waves. When passing through the polarizers, their amplitudes decrease by the factor cos α (α is the angle between the direction of oscillation of the wave and the plane of the polarizer).

When a light wave reaches the detector, it *possibly* causes a transition of a standing electron wave to a higher state – then a "photon" is detected.

If there is no transition, the light wave still adds up to one or more electron waves and thereby increases the probability of a transition when the next light wave hits or one that follows later.

This means:

Every later measurement is affected by every earlier one.

Even if we were able to measure the same photon pairs again, it would not be possible to predict the measurement results.

Bell's proof would only be feasible if the test series consisted of measurements that are independent of one another. The following should therefore apply: as soon as a measurement result is available, the respective measurement process is completely finished and does not affect the further measurement processes. (If the order was altered, the measurement results would remain unchanged.)

This is obviously not the case in our model: As just explained, every light wave that reaches the detector changes some of the standing electron waves (orbitals) – even if this change does not lead to a jump to the next higher state. So here, there are no test series that consist of individual events that are independent of each other, but only test series in which any subsequent measurement is influenced by any preceding one. Thus, the starting conditions of any individual measurement change in an unpredictable way, and this means:

There are no parameters λ from which the measurement results follow. Bell's proof cannot be derived.

In order to avoid any ambiguity here, I would like to emphasize the essential point again. Of course there are parameters in my model that completely determine each measurement result, but since these parameters also include how far the standing electron waves are away from the limit above which they jump to the next higher state, when an incoming light wave hits, these parameters do not meet the condition that must be fulfilled for Bell's parameters λ: Bell's parameters make the measurement on a certain object *repeatable*, they ensure that the results of further measurements on the same object are known. However, the "distances" from the jump limit change each time a new measurement is carried out (presumably they are also subject to constant fluctuations regardless of any measurement), and therefore also the result of the measurement on a certain object changes with each repetition. Thus there is no "more specific" prediction of any measurement – it sticks to the quantum mechanical probability.

We have thus achieved our goal. For this it wasn't even necessary to go into the proof itself – for our reasoning, the analysis of the measurement process was perfectly sufficient.

What is missing here, however, is a *detailed* description of what really happens in EPR test series. If the measured value cannot be predicted before the measurement – what actually ensures the connection between the measured values of the entangled objects?

In my book *"The Concept of Reality"* (p. 42 ff. and p. 142 ff.), I have given two formulas for the event probabilities that are based exclusively on local parameters and that lead to the same results as quantum mechanics. I think that the simplicity of these formulas is already an indication that the specific type of entanglement is somehow contained in the experimental setup and thus also in the statistics of the resulting measurements.

However, I refrained from presenting the associated physical processes because their description contains some *ad hoc* hypotheses. I believe that the path to a detailed understanding of what is really going on in EPR scenarios requires cooperation between theory and experiment.

(On pages 56-59 of *The Concept of Reality*, it is also shown – using John Bell's original paper[39] from 1964 – why his proof cannot be carried out.)

If one drops the idea of "particles" in its current form and replaces it with the assumption of continuous change in atomic and molecular states – until an discontinuous, observable transition occurs – then this means that the discussion about what really happens, so to speak "behind the scenes", during EPR experiments, is actually only now *beginning*.

Based on this assumption, the fact that we can predict the result of the polarization measurement on the other side after measuring the polarization on one side must be a consequence of the symmetry of both sides that arises during the preparation and execution of the experiment, and not, as EPR mistakenly assumed, a consequence of the fact that the "particle" had this polarization already before.

The decisive factor, however, is that we succeeded in refuting Bell's proof by eliminating its necessary premise.

As a result, it is now possible to claim the locality of reality, just as Einstein had in mind.

I have to admit that this assumption has always appeared to me as an obvious demand of reason.

[39] John Stewart Bell, *On the Einstein Podolsky Rosen Paradox*, Physics, 1, 195-200 (1964).

Status Report: Wrong Decisions in Physics

We have now analyzed most of the wrong physical decisions and wrong paths (which were already mentioned at the end of the Preliminary Report) and presented alternative solutions. It is time to look back and summarize what went wrong and how unfortunately the events were interconnected in some cases.

Let us start with the topic of the last chapter, Bell's proof of nonlocality. In 1935, Einstein, Podolsky and Rosen drew attention to the phenomenon of nonlocality.

The following statement comes from the inventor of the proof of nonlocality, John Bell himself:

"The discomfort that I feel is associated with the fact that the observed perfect quantum correlations seem to demand something like the "genetic" hypothesis. For me, it is so reasonable to assume that the photons in those experiments carry with them programs, which have been correlated in advance, telling them how to behave. This is so rational that I think that when Einstein saw that, and the others refused to see it, he was the rational man. The other people, although history has justified them, were burying their heads in the sand. I feel that Einstein's intellectual superiority over Bohr, in this instance, was enormous; a vast gulf between the man who saw clearly what was needed, and the obscurantist. So for me, it is a pity that Einstein's idea doesn't work. The reasonable thing just doesn't work."[40]

This statement is astonishing: Bell here passionately regrets that things are not as rational as Einstein assumed – even though he himself refuted Einstein. And he calls Bohr "obscurantist", even though Bohr was apparently right.

Basically, Bell's accusation is directed against nature itself, which does not allow for any reasonable explanation. However, then it cannot be considered a factual statement, but rather must be understood as an expression of desperation.

So what was the “reasonable assumption” that Einstein started from?

Let us assume we have carried out a measurement on a certain object. If the result of this measurement enables us immediately to determine the value of the attribute of another object, which is located (arbitrarily) far away, then there are only two possibilities: either the distant object

[40] John Stewart Bell, quoted by Jeremy Bernstein in *Quantum Profiles* [Princeton University Press, 1991, p. 84]

had this attribute already before the measurement, or the result must have been determined by some mechanisms ("programs") associated with the objects.

If one goes out from objects that are abstractions of everyday things, i.e. from *particles*, then this is actually the only reasonable and therefore compelling assumption: Obviously this *must* be the case, otherwise the measurement carried out *here* would have caused an *instantaneous* change *there*, in other words: a change that is not mediated by anything, and that would seem completely nonsensical.

However, Einstein was – even more than other physicists – committed to the assumption of particles because this assumption had given him his first major success: the description of the photoelectric effect as a collision process between two particles.

Unfortunately, as we have shown in Chapter 8, this assumption is a necessary prerequisite for Bell's proof. And since almost all physicists take the existence of particles for a fact, the question of locality is considered settled. The insight that this proof cannot be carried out in a reality which is based on waves is then impossible.

From this point of view, Bell's proof of nonlocality is the final and decisive blow against reason, the last wrong decision in a series of wrong decisions: photoelectric effect, Compton effect, quantum mechanical measurement process, collapse of the wave function, interpretation of the formalism.

All of these erroneous descriptions and interpretations are ultimately based on one single false assumption: the assumption of particles.[41]

Because the formalism of quantum mechanics is so successful, many physicists prefer to consider the interpretation problems insignificant or to ignore them altogether. As already stated in the Remark at the end of Chapter 7, this attitude is particularly problematic because the interpretation is needed to determine the direction of physical research.

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[41] However, the most important reason why the interpretation of quantum mechanics became impossible is the completely wrong conception of the "collapse of the wave function": In all previous interpretations it was assumed that the quantum mechanical description *before* the collapse and *after* the collapse refers *to the same object*. As we showed in the explanation of the double slit experiment, this is a mistake: the object (the "particle") that is detected is not identical with the object (the wave) that is described by the Schrödinger equation after the double slit. So as long as one tries to understand this "collapse" as a *transformation of an object*, the failure of the explanation is inevitable. It leads to the well-known absurdities.

It can be assumed that such an incorrect basic assumption must at some point result in a serious hindrance to physical progress.

There is also another, perhaps even more important consequence of the failure of interpretation: by abandoning reason, which John Bell so emphatically complains about, physics separates itself from the Enlightenment project. The line between physics and esotericism or fantasy becomes blurred.

One might think that this is not a problem of physics itself; But that is a mistake. This vagueness also exists in the minds of many physicists; also in physics itself hypotheses flourish that can certainly be compared with the fantasies of authors in popular culture.

This brings us to the end of this first part of the overview of the wrong decisions that have occurred in modern physics. All of the errors hitherto commented relate to quantum theory.

As can be seen, here everything is part of a uniform scheme, whose elements are already present in the double slit experiment, which I have placed at the beginning of the chapter on quantum theory for this reason.

The analysis of the wrong decisions in the other main strand of the development of theoretical physics, which is almost entirely Albert Einstein's work: special and general relativity, is less uniform and therefore more complex.

First to SR.

"Es ist der Relativitätstheorie oft vorgeworfen worden, dass sie der Lichtfortpflanzung ungerechtfertigterweise eine zentrale theoretische Rolle zuweise, indem sie auf das Gesetz der Lichtausbreitung den Zeitbegriff gründe. Damit verhält es sich wie folgt. Um dem Zeitbegriff überhaupt physikalische Bedeutung zu geben, bedarf es der Benutzung irgendwelcher Vorgänge, welche Relationen zwischen verschiedenen Orten herstellen können. Welche Art von Vorgängen man für eine solche Zeitdefinition wählt, ist an sich gleichgültig. Man wird aber mit Vorteil für die Theorie nur einen solchen Vorgang wählen, von dem wir etwas Sicheres wissen. Das gilt von der Lichtausbreitung im leeren Raum in höherem Maß als von allen anderen in Betracht kommenden Vorgängen – dank den Forschungen von Maxwell und H. A. Lorentz."[42]

("The theory of relativity has often been accused of unjustifiably assigning a central theoretical role to the propagation of light by basing the concept of time on the law of light propagation. The

[42] Albert Einstein, *Grundzüge der Relativitätstheorie,* 4. Auflage, Vieweg und Sohn, Braunschweig 1965, S. 19.

situation is as follows. In order to give the concept of time any physical meaning at all, it is necessary to use some kind of processes that can establish relationships between different positions. Which kind of processes one chooses for such a definition of time is in itself irrelevant. However, it will be advantageous for the theory to choose a process about which we know something certain. This applies to the propagation of light in empty space to a greater extent than to any other process that comes into question – thanks to the research of Maxwell and H. A. Lorentz.")

This is an extremely strange statement: Einstein's justification as to why light should be used "with advantage" to determine time is obviously completely inadequate. Fact is that the determination of time is correct ***only*** if it is carried out with light – or more generally: with processes at the speed of light. In any other way of determining time, nature would resist and refuse experimental confirmation. So it is by no means the case – as Einstein thought – that we have the choice as to how we determine the time relations; we ***must*** do it with light.

To demonstrate this fact, I have described the consequences of determining time using sound signals in The Concept of Reality (starting page 69 below). From this follows that sound signals have the same speed for all uniformly moving observers. However, time defined in this way applies *only* to sound and phenomena derived from it and to nothing else.

The same would be the case for any other choice: time would only apply to the process chosen to determine time and to all phenomena derived from it and to nothing else. Only with light it seems to be different: the time relationships determined by light apply generally. And only then, once you have made this clear, you will face the crucial question:

Why is this so? Why does nature obey the space and time relations determined by light?

But if one does *not* ask this question and justifies the SR using the known postulates, then of course one obtains the correct result, but the fundamental mechanism of reality, by which the time relations are generated – which we presented in Section 3.1. The Time Structure of Reality and carried out in Chapter 6 on the special theory of relativity – remains undiscovered.

Elsewhere[43] Einstein declared, that the assumption that light moves at the same speed in all directions with respect to any uniformly moving observer, is a "stipulation that we can freely make in order to arrive at a definition of simultaneity."

[43] A. Einstein, *Über die spezielle und die allgemeine Relativitätstheorie,* Akademie-Verlag, Berlin 1973, p. 22f.

That is also not correct. We are by no means free to decide about this. The truth is that nature designed it that way. And here again applies: If we decided differently, nature would resist.

So how should we judge the introduction of SR? Of course it is a great achievement. It would be downright absurd to imagine physics without it, and it took Einstein's genius to break away from Newton's concept of time.

But on the other hand, the way in which Einstein carried out this separation is at the same time a misfortune for the development of physics. As we explained in Section 3.1, the recognition of the relativity of time would also have been the opportunity, to take a look at the fundamental level of reality for the first time.

For that, however, it would have been necessary to understand the true reason why time relations are determined by light. However, Einstein's errors, which are revealed through the above quotations, made it impossible for himself and for everyone who followed him, to recognize the real cause of the fundamental importance of the speed of light.

As stated at the beginning of Section 3.1, this is because though Einstein recognized the relativity of simultaneity, he was not able to see that his arguments actually go much further – that they show that *time relationships are* ***created*** *by processes,* and that *therefore the necessary uniqueness of the time system is only guaranteed if there is only one single speed.*

According to this argument then applies: ***There is only the speed of light***. *All other speeds must be derived from it.*

This in turn leads to the considerations of Chapter 6, where we *constructed* the relativistic space and time relationships based on the assumption of metric waves at the speed of light.

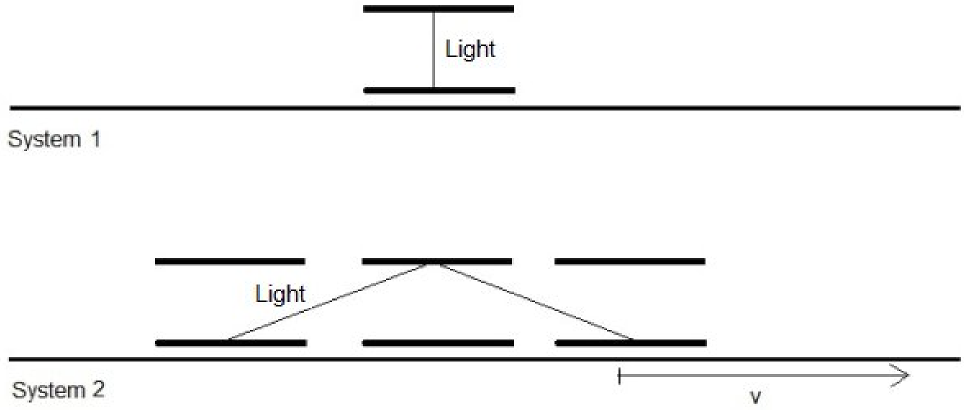
So this is the first problem with Einstein's introduction of SR: the actual reason for the relativistic space-time structure not only remains undiscovered, but becomes almost invisible behind pseudo-explanations.

In addition, as with quantum theory, the trust in our reason and ability to understand is seriously damaged, and unnecessarily so. To show this, we proceed as follows:

We look at two inertial systems, which move past each other with relative speed v.

Each system contains a light clock in which light moves up and down between two fixed mirrors. The time period between two reflection points defines the time unit.

The sketch shows the clocks at 3 times in quick succession, as well as the light paths in between:



There is an observer in both systems. For each of the two observers, the light in her own clock appears to travel the *shorter* distance, which leads to the conclusion that the time measured in this way passes *more slowly* in the *other* system.

Formally there is no problem. There is complete symmetry. *Ontologically*, however, this symmetry is absurd for the following reason:

Light moves *in space*, and therefore there must be a *real path* of light in space. This "true path" is then perceived differently by differently moving observers, as is the case with every physical process.

The system in which the light in the clock takes the *shortest* true path must then be the one in which time passes the fastest, i.e. the *absolute rest system*.

On the other hand, taking the usual standpoint – that of complete symmetry – is tantamount to saying that *this true path of light does not exist*.

This is a claim of such blatant absurdity that it would only be acceptable under extreme logical constraint. However, there is no such constraint – the formal symmetry can be explained quite simply as follows:

We first add to the scenario: We set up not just *one* light clock in both systems, but a whole series of such clocks, one behind the other, parallel to the direction of movement. The time comparison can then be carried out by both observers in the following way: the display of the clock that is directly placed at the other observer is compared with the display of the clock in the own system that it is currently moving past. This makes it possible to (almost) directly compare the passage of time in both systems.

Let us assume that system 1 is the absolute rest system.[44] First we look at the situation from the point of view of observer 1, who is in this system. Here, nothing has changed compared to the usual view: the time comparison carried out in the manner just described shows that the clock of the moving observer runs slower by the factor $k = \sqrt{(1 - v^2/c^2)}$.

Now we take the position of the moving observer 2. As explained in 3.1, for her the following applies:

Since the time structure is created by causal processes at the speed of light, events that occur *behind* her must – *for her,* compared with observer 1 – be *shifted into the future*, simply because the light emitted from the event-locations reaches her *later* than observer 1. (However, I would like to remind you again: it is not just about *information* about temporal relationships, but about their *creation*.)

Let us now look at the situation exactly at the moment when the two observers are facing each other: Let us assume that at this moment the clocks placed directly at the two observers show the same time.

According to what has just been said, the clocks placed *behind* the moving observer show a *later* time than those of the rest system directly opposite them, and the further they are away from observer 2, the greater is this time difference.

If the moving observer now carries out the time comparison in the previously defined manner, then the following happens:

Seen from the moving observer, the clock that is directly at the observer at rest passes all the clocks that are behind the moving observer, one after the other.

However, as just noted, these clocks show increasingly *later* times than the clocks of the rest system. The clock at the resting observer therefore increasingly lags behind the respective comparison clocks of the moving system.

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[44] I remind you that we already showed at the beginning of Chapter 6 (in 6.1) that the assumption of the absolute rest system is necessary in order to avoid nonsense.

Thus the moving observer concludes that the time of the rest system is *slowed down* compared to her own time.

This argument is already sufficient to see that also for the moving observer time appears slowed down in the other system.

In order to reconstruct the relativistic result quantitatively, all that remains is to determine how large the factor of this slowing down is.

To determine this factor, two counteracting circumstances must be taken into account:

On the one hand, due to the longer light paths, the time of the moving system ***actually* passes slower by the factor k** than the time of the rest system.

On the other hand, from the shifting of the events behind the moving observer into the future (the clocks which display times that lie in the future and which successively are compared with the clock of the resting observer) follows that the passage of time in the moving system ***appears* faster by the factor 1/k²**.

(I don't want to use mathematics in this informal description. However, elementary mathematical knowledge is sufficient for a check.)

To compare the passage of time in both systems, both factors must be combined. The result is apparently that for the moving observer the time of the rest system appears to be s***lowed down by the factor k²/k = k***, in agreement with the special theory of relativity.

This means:

Although the clock of the resting observer actually goes faster than all the clocks of the moving system that it passes, the moving observer must still draw the conclusion from the successive clock comparisons that the time in the absolute rest system is slowed down by the factor k.

In short: For the moving observer, the time of the system at rest appears – compared to her own time – to be stretched to the same extent as the time of the moving system appears to the observer at rest.

So it can be claimed: The relativistic phenomena are in no way contradictory to our *a priori* conception of space and time. On the contrary – consistently analyzed in terms of their *real prerequisites*, they even turn out to be *necessary consequences* of this conception. The previous lack of understanding was only due to the fact that no real explanation of special relativity has ever been carried out.

Consequently, we would now have to ask why not only light clocks, but also all other clocks and *all physical processes* in general adhere to the time relationships determined by light. But we already did that in Chapter 6. The answer is:

Nature obeys the space and time relationships determined by light signals because there is only the speed of light and phenomena derived from it.

We have shown that, under this assumption, the relativistic space-time structure can not only be understood but also *constructed*, and that this construction, no matter how remote from reality it may initially seem, leads very directly to matter waves. In the next chapter it will turn out that by adding another metric assumption, essential parts of the entire quantum mechanical reality come into view.

But let us now return to our topic. What remains is the assessment of the general theory of relativity from the metric-dynamic perspective.

We start from the following formulation of the special principle of relativity:

SRP: Every un-accelerated observer is entitled to consider herself to be at rest.

Since this idea of relativity is initially based on the conviction that no movement can be asserted in relation to space, Einstein felt the need from the beginning to generalize the principle of relativity so that it applies to *all* observers, including accelerated ones. He thought he could achieve this through the following postulate – the general principle of relativity:

GRP: Any observer who moves in any way is entitled to consider herself to be at rest. She just has to relate all the accelerations she experiences to a gravitational field.[45]

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[45] The fact that this possibility exists at all is based on the equality of inertial and heavy mass. Since Einstein, it is clear that every theory of gravity must contain this equality as a structural principle. As established in Section 4.7, metric-dynamic gravity offers a "direct" explanation for the equality of gravity and inertia: here, the freely falling system (from infinity with initial speed 0) *actually* rests relative to the space that surrounds it, because this space, understood as *metric* space, flows *itself* at the same speed – this is how gravity is defined in MDG. Therefore, keeping a body in the same place in the gravitational field means accelerating it against the metric flow. In other words, *heaviness* ***is*** *inertia*.

From a metric-dynamic perspective, our weight that we feel on the earth's surface is not a result of gravity, but of inertia: the earth's surface accelerates us against the metric flow, which moves (accelerated) through us at a speed of 11 km/s.

First of all, it is clear that the first part of GRP is a generalization of SRP.

However, the additional condition completely changes the character of this "relativity". Relativity "generalized" in this way no longer has any relation to the question of whether motion against space exists.

The original postulate to extend the relativity of movement in relation to space to accelerated observers is therefore not fulfilled by this generalized relativity – rather it creates a *purely formal* symmetry.

This symmetry is "purely formal" because – as in Einstein’s well-known example of the passenger in an accelerating train – there is actually no gravitational field. Here, it is completely clear that the observer system is *not* at rest.

This means: The *asymmetrical reality* is opposed to a *symmetrical formalism*. A distinction must therefore be made between reality and description.

Since my book is based on this distinction, from the standpoint taken here this is self-evident. However, with the step from special to general relativity, Einstein finally completed the – from our point of view inadmissible – equation of reality and formalism, which had already been indicated in the SR.[46] Only under this condition was it possible for him to understand this step as a generalization.

Finally, let us ask ourselves what Einstein's approach means for the development of theoretical physics. However, I will not presume to judge this in general, but will continue to limit myself to assessing the consequences of his approach from a metric-dynamic perspective.

Einstein was the first to see that there is a connection between observable reality and the metric basis of this reality – that is, between mechanics and metric. The reasoning that made this possible for him is as follows:

Let us consider an observer who experiences an acceleration – for example an observer on a rotating disk. According to GRP she is entitled to consider herself to be at rest and to relate her acceleration to a gravitational field.

This now creates connections to both metric and mechanics. The metric changes result from the special theory of relativity: due to the observer's movement, her tangential scale is shortened and

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[46] I refer you to the quotation at the end of Chapter 6.

her time passage is slowed, and of course she can also express the acceleration she experiences in terms of mechanical quantities: mass, energy, momentum. Thus, her state can be described in both ways, and this means that the metric changes and the mechanical conditions can be equated.

As great as this train of thought is, from the metric-dynamic perspective it is (unfortunately) problematic in several ways:

1. Because *all* accelerations are interpreted gravitationally, the formalism derived from this contains also physically impossible cases.

2. Since all metric changes in space and time are tied to gravity, it becomes impossible to recognize metric as the fundamental structure that generates not only gravity but *all* interactions and thus all of reality.

3. The central concept of metric-dynamic gravity – the metric flow – remains unattainable with Einstein's approach. Getting there requires a conception of (metric) space that is fundamentally different from Einstein's.

4. Since the actual causal structure that lies in the metric basis of reality remains hidden, the connection between mechanics (energy-momentum tensor) and metric (Einstein tensor) appears as fundamental causal connection, for which it is not suitable.

9. Process that Generates Reality ⟶ Electromagnetism, Atomic Structure

9.1. Preliminary Remark

As mentioned in the preliminary report, it was by no means my original intention to research gravity and electromagnetism. I just wanted to find out whether equations (0) and (1), which resulted from metaphysical considerations, lead anywhere.

Since the quantity $\sigma(r)$ in equation (0) has to be understood as both metric density of length and metric density of angle, it suggested itself to start in both cases with the respective simplest metric assumption.

For the metric density of length, this is the assumption of a spherically symmetric compression, through which the radius of a spherical spatial region becomes smaller by m units.

The surface of the sphere is then moved inwards by m units, so that for every point outside this sphere the distance from the center O appears to be m units shorter.

So if the metric density of the length in the outer space was 1 *before*, it should be $(r - m)/r$ *after*.

To my great astonishment, this assumption immediately – after just one line – led to Newtonian gravity, and, after closer inspection (light moves *in* the metric flow), to results that agree with GR. This was more than enough for the intended goal of knowing whether equations (0) and (1) made any physical sense, and so a short time later I turned to another topic: antimatter (which is presented in Chapter 5 of this book).

Then it remained to be clarified where one would get if one understood σ as the metric density of the angle. In this case, the simplest metric assumption is again a spherically symmetric change, which now corresponds to a compression of angle, which then obviously means that a complete rotation is no longer equal to 360°, but – based on the internal, altered angle measure – *more* or *less* than 360°.

If one now assumes that the metric change of the angle leads to electromagnetism – which seems to be obvious anyway – and defines μ ($\mu \in \mathbb{R}$, $\mu > 0$) as *positive geometric charge* (analogous to the *geometric mass* m) and $-\mu$ as negative charge, then a large part of the quantum mechanical atom model can be reconstructed with little mathematical effort.

9.2. Connection between Planck-Length, Geometric Mass and Particle Frequency

Before we move on to electromagnetism and atomic structure, we must consider a hypothesis that substantiates the connection between Planck length, geometric mass and the two quantities associated with this mass: particle frequency and Compton wavelength, in a metric-dynamic way.

This hypothesis represents the first concrete step for the build-up of the metric-dynamic structure of reality, which is the main theme of this book: it provides clues as to how this structure could begin at the metric, wave-based fundament.

Although this is more of a concept or vision than a theory, even this preliminary version is already so rich in new (metric) connections that I would like to present it here.

First of all, the conditions that led to this hypothesis:

When deriving the theory of relativity (Chapter 6), we represented the state of motion of objects by superimposing (metric) waves at the speed of light. From this we also obtained matter waves in a very simple way.

Our representation of gravity has shown us that the metric continuum of reality is constructed of *flow lines*. This means that the waves do not run in the metric continuum, which – in the context of special relativity – is thought to be at rest, but *in the metric flows*. (See the wave equations on pages 30 and 31).

Since we consider these waves to be the basis of reality, it makes sense to associate them with a fundamental unit, i.e. with the Planck length.

So we assume:

In the metric flows, whose stationary, spherically symmetric state corresponds to the gravitational field of a central mass, there are standing waves. Its wavelength λ is equal to the Planck length. They form the basis of material structures.[47]

[47] If the universe were a closed metric structure, then the idea of standing waves would actually be the first and simplest thing one would expect as a result of self-organization. (I will address the problem that arises when the universe is seen as an open structure in Chapter 10.)

Thus $\quad \lambda := \text{Planck-length} := \lambda_{Pl}$

where $\quad \lambda_{Pl} = \sqrt{\dfrac{hG}{c^3}} = 4.051 \ldots \; 10^{-35}$ (meter).

To demonstrate how this metric quantization works, we will immediately proceed with the first conclusion. It bridges more than 40 orders of magnitude and provides the above-mentioned metric-dynamic justification of known relationships between fundamental quantities.

9.3. Phase-Waves in the Radial Flow

Let us consider the case of a spherically symmetric, stationary flow v into a gravitational center Z. Seen from an observer at rest relative to Z, the standing Planck waves in the flow are *not* standing waves. For her the flow is a *moving* system. The Lorentz transformation breaks the phase coincidence in the standing wave.

From $\quad f(r,t) = \sin(2\pi \; t \, \nu_{Pl}) \cos(2\pi \, r \dfrac{1}{\lambda_{Pl}}) \qquad (\nu_{Pl} \, \lambda_{Pl} = c) \qquad (1)$

– which represents a standing wave *in the flow*, for the resting observer results

$$f'(r,t) = \sin 2\pi \, (t \, \nu_{Pl} \frac{1}{k} - r \, \nu_{Pl} \frac{v}{c^2} \frac{1}{k}) \; \cos 2\pi \, (t \, v \frac{1}{\lambda_{Pl} \, k} - r \frac{1}{\lambda_{Pl} \, k}) \quad (k = \sqrt{1 - \frac{v^2}{c^2}}) \qquad (2)$$

For the resting observer, the standing wave in the flow is transformed into a wave superposition that consists of

$$\Psi_1 (\lambda_1, \nu_1) \text{ and } \Psi_2 (\lambda_2, \nu_2)$$

where

$$\lambda_1 = \lambda_{Pl} \frac{c}{v} k \qquad \nu_1 = \nu_{Pl} \frac{1}{k} \qquad (3)$$

$$\lambda_2 = \lambda_{Pl}\ k \qquad\qquad \nu_2 = \nu_{Pl}\ \frac{v}{c}\ \frac{1}{k} \tag{4}$$

Equations (1) and (2) are identical to the equations from 6.5. Only λ has been replaced by λ_{Pl}.

Thus Ψ_1 is again a matter wave, and Ψ_2 has the speed of the particle associated with this wave.

We now determine the distance r_1 from Z that corresponds to exactly one wavelength λ_1 of the phase wave Ψ_1 that was created by the transformation.

In addition to the special-relativistic phase shift described by (2), it must be taken into account that the length differential in the flow is larger by the factor $1/k = (1 - (v/c)^2)^{-1/2}$ than the length differential of the system at rest relative to Z. The wavelengths in the flow are therefore increased by the factor 1/k.

We therefore set

$$r_1 = (\lambda_{Pl}\ \frac{c}{v}\ k)\ \frac{1}{k}$$

$$r_1 = \lambda_{Pl}\ \frac{c}{v} \tag{5}$$

How large is the flow v(r)? Here, the conditions correspond to those of the Hybrid System. Therefore the value of v from equation (9h) must be chosen:

$$\frac{v}{c} = -\sqrt{\frac{m}{r}} \qquad \text{(m is the geometric mass)}$$

With $\dfrac{c}{v} = \sqrt{\dfrac{r_1}{m}}$ (here only the absolute value of v matters) follows from (5)

$$r_1 = \lambda_{Pl}\sqrt{\frac{r_1}{m}}$$

Therefore

$$\boxed{r_1 = \frac{\lambda_{Pl}^2}{m} \qquad \text{or} \qquad r_1\, m = \lambda_{Pl}^2} \qquad (6)$$

r_1, the distance from Z, is equal to λ_1, the wave-length of the phase wave which appears in the system at rest relative to Z (due to the Lorentz-Transformation of the standing wave in the flow), if

$$r_1 = \frac{\lambda_{Pl}^2}{m}$$

This, however means: r_1 is equal to the *Compton wave-length* λ_C, because it applies

$$\lambda_C = \frac{\lambda_{Pl}^2}{m}$$

E.g. for an electron:

$$m_e = 6.763 \quad 10^{-58} \text{ (meter)}, \quad \lambda_{Pl} = 4.051 \quad 10^{-35}$$

$$\frac{\lambda_{Pl}^2}{m_e} = 2.426 \quad 10^{--12} = \lambda_{Ce}$$

At the position r_1 there is – besides the almost unchanged Planck-frequency

$$\nu_1 = \nu_{Pl} \frac{1}{k}$$

a second, much smaller frequency (see (4))

$$\nu_2 = \nu_{Pl} \frac{v}{c} \frac{1}{k} = \nu_{Pl} \sqrt{\frac{m}{r_1}} \frac{1}{k} \qquad (7)$$

which, because of $\nu_2 \lambda_1 = \nu_2 \lambda_C = c$ corresponds to the frequency ν_m of a particle with the geometric mass m.

The flow that creates the phase wave is *spherically symmetric*. This means:

On a spherical surface with radius λ_C there is an in-phase oscillation with the frequency of the particle.

Of course, this is not yet a model of a particle. On the other hand, it is also more than just a mathematical connection between particle mass and particle frequency, because it contains a structural element: the idea of in-phase oscillation on a spherical surface. (Exactly this idea is needed below.)

The relationship just derived between the frequency ν_m, the wavelength λ_m (with $\nu_m \lambda_m = c$) and the mass m applies not only in the case of a particle, but also in general.

So it can be claimed: The following equations (8) and (8')

$$\lambda_m \, m = \lambda_{Pl}^2 \tag{8}$$

(and, because of $\lambda_m \nu_m = c$)

$$m \, c = \lambda_{Pl}^2 \, \nu_m \tag{8'}$$

represent the metric-dynamic equivalent of $M c^2 = h\nu$ (or $E = h\nu$) and $E = M c^2$. (See also the according note in the Addendum)

Alternatively, one can set $\bar{\lambda}_{Pl} = \sqrt{\frac{\hbar G}{c^3}} = 1.616... \; 10^{-35}$ (meter). Then applies (with $\bar{\lambda}_m = \lambda_m / 2\pi$)

$$\bar{\lambda}_m \, m = \bar{\lambda}_{Pl}^2 \tag{8''}$$

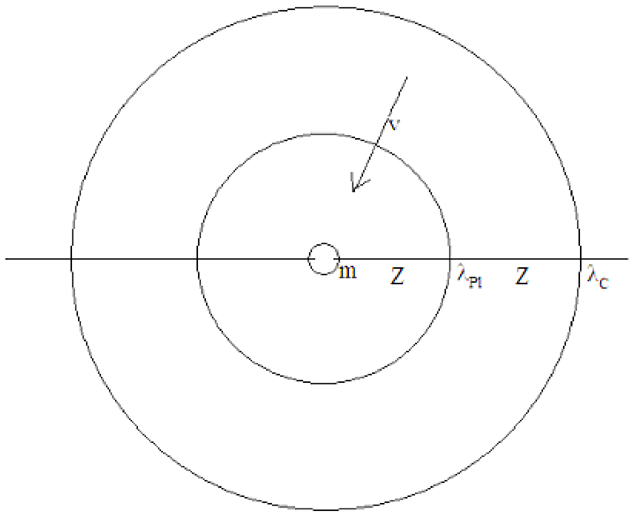
Remark

In (8) it can be seen that λ_{Pl} is the geometric mean of m and λ_C.

This means: There is a simple indication that a relationship between 3 quantities in a metric flow, whose speed is inversely proportional to $r^{1/2}$ may be mediated by a phase wave:

If all 3 quantities are expressed by lengths, then one length must represent a metric defect, and another length must be the geometric mean of the other two. (Another case of this kind will occur in the atom structure.)

Scaled logarithmically, the quantities m, λ_{Pl} and λ_C, whose connection is mediated by the radial flow v, can be represented as follows:



(S1)

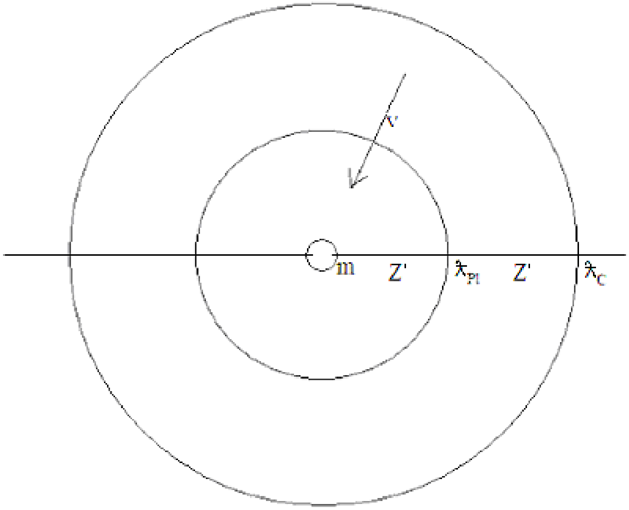
Z is a multiplicative factor associated with gravity, comparable to the fine structure constant $1/\alpha$ in electromagnetism. (More on this later.)

It applies: $\quad m\,Z = \lambda_{Pl} \quad$ and $\quad \lambda_{Pl}\,Z = \lambda_C \qquad (9)$

For the electron $\qquad Z_E = 5.990\ 10^{22}$

For the proton $\qquad Z_P = 3.262\ 10^{19}$

In (S14), λ_{Pl} and λ_C can be replaced by $\bar{\lambda}_{Pl}$ and $\bar{\lambda}_C$. Thes the depicted fact does not correspond to (8), but to (8"):



(S1')

Here is $\qquad m\,Z' = \bar{\lambda}_{Pl} \qquad$ and $\qquad \bar{\lambda}_{Pl}\,Z' = \bar{\lambda}_C \qquad$ (9')

For the electron $\qquad Z'_E = 2.390\ 10^{22}$

For the proton $\qquad Z'_P = 1.3014\ 10^{19}$

The model just designed represents a *phase wave structure,* through which the relationship between the quantities *Planck length, mass* and *frequency* is established in a geometric – or let us say: in a metric-dynamic way – not only in the case of a particle, but also in general.

9.4. Electromagnetism: Preface

Gravitation – in the form of general relativity – and electromagnetic interaction – in the form of quantum electrodynamics – differ from each other in several ways. Here is a table with some facts:

G *is* the curved spacetime	EM takes place *in* the (flat or curved) spacetime
G is always positive	EM is positive and negative
G is a pseudo force; all objects move along geodesics	The interaction is effected by means of particle exchange
The frequency difference between two identical particles with different distances from a mass can be explained in two ways: By the different passing of time and by the energy difference	The frequency difference between two electrons with different distances from a positively charged atomic nucleus can be explained only in one way: by the energy difference
G cannot be isolated	EM can be isolated, but in field-free space there are detectable effects on the phases of electrons
G acts universally	EM acts only on charged objects

Even if formal similarities exist, the differences listed above appear so great that it is doubtful whether the realms of the phenomena described by the two theories can be described in a unified representation – at least in the form in which the theories currently present themselves . They appear like two buildings, each of which follows a convincing internal logic, but which obey completely different functional and aesthetic principles.

One is involuntarily reminded of Wolfgang Pauli's statement: "What God has separated, man should not put together."

However, I do not believe that the incompatibility of the two interactions was imposed by God or nature.

Rather, I think it is an artifact of our access to nature which, if handled appropriately, will dissolve into nothing. In fact, all of the characteristic features of both interactions emerge to a certain extent "by themselves" if the program that was started with the metric-dynamic representation of gravity is simply continued.

Gravitation was found to be an accelerated metric flow caused by longitudinal metric density changes. In the spherically symmetric case, gravitation is a *steady state of the longitudinal metric flow*, generated by a change in the differential radial measure dr. This completes the interpretation of the longitudinal parameters metric density and metric flow – in the sense that they are bound to gravitation and cannot be used in any other way.

In addition to the parameters metric length density and longitudinal flow, in the metric-dynamic universe there are also the analogous parameters metric angular density and transverse flow.

So inevitably the assumption arises that, in the spherically symmetric case, electromagnetism is a *steady state of the transverse flow*, which is generated by a change in the differential angular measure $d\varphi$. This simple conjecture will now lead us – without any quantum theory – deep into the realm of quantum theoretical phenomena.

9.5. Electromagnetism: Definition

Everything that follows refers to the spherically symmetric case of a central geometric mass m or a central geometric charge μ. ($m \in \mathbb{R}$, $\mu \in \mathbb{R}$. Both m and μ have the dimension length.)

Three spatial dimensions are assumed. r and φ are polar coordinates in an arbitrary plane through the center O. σ is the metric density of the length, η is the metric density of the angle. c is set to 1.

<u>Gravitation</u> is *change in the metric density of the length*.

In the case of a central geometric mass $m > 0$, the metric length density $\sigma(r)$ $(r > m)$ decreases towards O. The distance from O for each point is m units smaller than in the undistorted continuum. (2m from a relativistic point of view.)

<u>Electromagnetism</u> is *change in the metric density of the angle*.

In the case of a central geometric charge $\mu > 0$ ($r > \mu$), the metric angular density $\eta(r)$ decreases towards O. The circumference of every circle with center O is $2\pi\mu$ units smaller than in the undistorted continuum. Here, a whole circle has less than 360°. The circle with radius μ has 0°, i.e. its circumference disappears.

For $\mu < 0$, the circumference of every circle is greater by $2\pi|\mu|$. The circle with radius $|\mu|$ has 720°.

To illustrate the almost complete analogy that exists between gravity and electromagnetism (with respect to the parameters metric length density σ, longitudinal metric flow v and radial differential dr on the one side, metric angular density η, transverse metric flow w and angular differential $d\varphi$ on the other side), I will compare the definition of EM and the resulting elementary facts with the analogous circumstances of G.

<u>Gravitation</u>	<u>Electromagnetism</u>	
$\boxed{\sigma = \dfrac{r - m}{r}}$	$\boxed{\eta = \dfrac{r - \mu}{r}}$	(10)
m is the *geometric* m*ass*	μ is the *geometric charge*	
$m > 0 \iff$ matter	$\mu > 0 \iff$ positive charge[48]	
$m < 0 \iff$ antimatter	$\mu < 0 \iff$ negative charge	
$\boxed{\sigma = \dfrac{dr}{dr'}}$	$\boxed{\eta = \dfrac{d\varphi}{d\varphi'}}$	(11)

48 The assignment of $\mu > 0$ to positive charge is initially arbitrary. It will become clear below that this assignment is necessary for correspondence with quantum mechanical specifications.

From (10) and (11) follows

$$\boxed{dr' = \left(1 - \frac{m}{r}\right)^{-1} dr}$$

$$\boxed{r\, d\varphi' = \left(1 - \frac{\mu}{r}\right)^{-1} r\, d\varphi} \qquad (12)$$

The ratio of the arc lengths $r\varphi'$ and $r\varphi$ is the inverse of the ratio of the arc differentials $rd\varphi'$ and $rd\varphi$:

$$\frac{r'}{r} = 1 - \frac{m}{r}$$

$$\frac{r\,\varphi'}{r\,\varphi} = 1 - \frac{\mu}{r} \qquad (13)$$

This means: any radial distance is by $|m|$ units smaller or greater:

$$PO = r \quad \Leftrightarrow \quad (PO)' = r - m$$

From (13) follows: the circumference $2\pi r$ of a circle around O is by $|2\pi\mu|$ shorter or longer:

$$U = 2\pi r \quad \Leftrightarrow \quad U' = 2\pi(r - \mu) \qquad (13')$$

The arc differential $rd\varphi$ remains unchanged:

$$rd\varphi' = rd\varphi, \quad dt' = dt$$

The radial differential dr remains unchanged:

$$dr' = dr, \quad dt' = dt$$

9.6. The Metric Flow that Rotates around the Center

In the following, we will initially proceed in the same way as with gravity: we first determine the magnitude of the transverse (here rotating) flow w(r) and then the metric conditions in a local, non-relativistic flow system S_F. The totality of the metric conditions of all S_F is again represented by the system S, which is at rest relative to O. (The local relativistic flow system S'_F can be dispensed with, since here a direct transition from S_F to the global relativistic system S' is possible.)

We then turn to the second task of this chapter: the construction of the metric-dynamic atom model.

We will show the following: The metric changes resulting from the *geometric charge of the proton* and the *geometric mass of the electron* (!) interact in such a way that exactly the standing wave states are formed that correspond to the states of the quantum mechanical atom model.

Equation (21) from 4.6.

$$dr_F = dr\,(1 - v^2)^{-1}$$

shows the general relationship between the flow velocity v(r) and the length differential dr_F in the flow. Thus ***this relationship must also apply to the transversal flow velocity w(r) and the length differential in the transversal flow***.

In the spherically symmetric case, the transversal flow rotates around the center (see the following outline (S2)), and therefore the length differential in the transversal flow is identical with the arc differential $r\,d\varphi_F$. Thus according to equation (21) applies

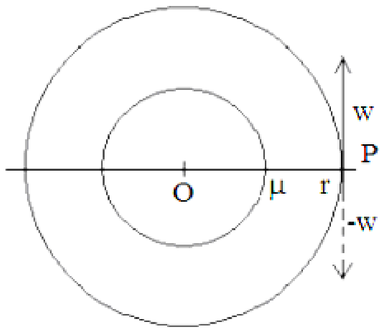
$$r\,d\varphi_F = r\,d\varphi\,(1 - w^2)^{-1} \qquad (d\varphi \text{ unaltered differential}) \qquad (14)$$

Then $$1 - w^2 = \frac{r\,d\varphi}{r\,d\varphi_F} = \eta = 1 - \frac{\mu}{r}$$

and therefore [49] $$w = \pm\sqrt{\frac{\mu}{r}} \tag{15}$$

In the case of positive charge $\mu > 0$, w is real, at negative charge $\mu < 0$, w is imaginary.

Here is an outline that illustrates the transversal flow. In the spherically symmetric case, this flow rotates around O. Depicted is an arbitrary plane through O. P is a point at the distance r from O.



(S2)

Since (S2) applies to *any* plane through O, to the point P must be assigned the velocity w(r) or –w(r) *in any direction* on the tangent plane to the sphere, where P is located.

I shall refer to this peculiar fact, which exhibits already quantum mechanical features, a little later extensively.

<u>What has been said so far can be summarized as follows:</u>

The *gravitational field* of a geometric mass m is defined as the stationary, spherically symmetric state which is caused by the fact that, if m > 0 (in the case of matter) *any distance from the center O* is by m units smaller – or, if m < 0 (antimatter), by m units greater – than in the flat continuum. This

[49] Also here, as in Section 9.3, the conditions of the hybrid system are met, since the usual description of the electromagnetism takes place in flat spacetime. Thus the factor 2 does not apply. (Compare (9) from Chapter 4.)

metric alteration causes a *radial flow* v(r) which is real or imaginary. (The circumferences of circles around O remain unchanged.)

The *electromagnetic field* of a central geometric charge μ is defined as the stationary, spherically symmetric state which is caused by the fact that, if $\mu > 0$ (in the case of positive charge) *the circumference of any circle around O* is by $2\pi\mu$ units *shorter* – or, if $\mu < 0$ (in the case of negative charge) by $2\pi\mu$ units *longer* – than in the flat continuum. This metric alteration causes a *flow* w(r) *that rotates circularly around the center O* and which is real or imaginary. (Radial distances remain unchanged.)

9.7. Positive and Negative Charge

In the metric dynamic model, the relationship between positive and negative charge is analogous to the relationship between matter and antimatter. The metric deformations are in both cases opposite to each other.

Thus it can be geometrically understood why the consequences of positive and negative charge cancel each other out.

In the case of matter and antimatter, the metric alterations relate only to the radial distances r, in the case of positive and negative charge, they relate only to the arc lengths $r\varphi$.

The following applies to S and therefore also to S_F that has the same differential measures as S:

If, according to (12), positive charge is defined by $$r\,d\varphi_F \;=\; (1 - \frac{\mu}{r})^{-1}\, r\,d\varphi \qquad (\mu > 0)$$

– with the consequence that to the circumference U_F of a circle around O in the continuum altered by the charge μ applies:

$$U_F(r) \;=\; 2\pi(r - \mu)$$

– then the equally large negative charge is defined by

$$r\, d\varphi_F \quad = \quad (1 + \frac{\mu}{r})^{-1}\, r\, d\varphi$$

It follows $\qquad U_F(r) \quad = \quad 2\pi(r + \mu)$

As was the case with matter and antimatter, the squares of the metric flows (of positive and negative charge) cancel each other out:

Positive charge: $\qquad w_{pos} \quad = \quad \pm\sqrt{\frac{\mu}{r}}$

Negative charge: $\qquad w_{neg} \quad = \quad \pm i\sqrt{\frac{\mu}{r}}$

Therefore: $\qquad {w_{pos}}^2 \; + \; {w_{neg}}^2 \quad = \quad 0$

9.8. The Transition to an Observer System

Exactly in the same way as in the description of gravity, a local system S_F in the flow can be used as basis for the transition to a (relativistic) observer system S'.

According to (14) and (15), a local system S_F that rotates with the flow is characterized by

$$S_F : (\, dr_F \; = \; dr, \;\; d\varphi_F \; = \; (1 - \frac{\mu}{r})^{-1}\, d\varphi\,) \qquad (16)$$

The radial distances remain unchanged, the arc differential is altered. (The arc differential $r\, d\varphi_F$ is identical with the length differential of the local flow system S_F .)

Now from S_F (i.e. from the neighborhood of any point P in the flow with PO > μ) can be transformed to a local observer system S' that is not rotating but resting relative to O.[50] The transformation factor is that of the Lorentz-Transformation

$$k = \sqrt{1 - w^2} = \sqrt{1 - \frac{\mu}{r}} \qquad (17)$$

Every local area of S' moves with velocity –w relative to the local flow-system S_F. In order to determine the length differential of S' we proceed therefore as we did in the case of gravitation:

The (tangential) length differential $r\,d\varphi'$ of S' results from multiplying the length differential of S_F (here it is identical with that of S'_F) with k, and the time differential dt' by multiplying the time differential of charge-free space with k.

Then follows for the (tangential) length differential $r\,d\varphi'$ of S' according to (16)

$$r\,d\varphi' = r\,d\varphi_F\; k = r\,d\varphi\,(1 - \frac{\mu}{r})^{-1}\,(1 - \frac{\mu}{r})^{\frac{1}{2}}$$

$$r\,d\varphi' = r\,d\varphi\;(1 - \frac{\mu}{r})^{-\frac{1}{2}} \qquad (18)$$

and for the time differential dt'

$$dt' = dt\;(1 - \frac{\mu}{r})^{\frac{1}{2}} \qquad (19)$$

The radial differential dr remains unchanged.

---

50 Here, the intermediate step to a *relativistic* flow system S'_F, which was required in the description of gravity, can be dispensed with, because the factor 2 that is substantiated by this step does not appear at all under the conditions of the hybrid system.

From (18) follows that, with respect to an observer at rest relative to O, for the circumference U' of a circle around the center O applies:

$$U' = U \left(1 - \frac{\mu}{r}\right)^{\frac{1}{2}} \tag{20}$$

From (19) follows that in electromagnetism the transverse (here rotating) metric flow w(r) changes the passage of time in the same way as the radial metric flow v(r) in gravity:

For an observer located at a distance r from O and resting relative to O, time passes slower by the factor k in (17) in the case of positive charge, compared with the time in charge-free space.

In the case of negative charge, in (17) and (19) applies $\mu < 0$ and therefore ***the passage of time is accelerated by k.***

If the absolute values of positive and negative charges are equal, the squares of the metric flows cancel each other out, and the time again equals the time outside the field.

9.9. The Fundamental Difference between Gravitation and Electromagnetism

With respect to all hitherto deduced facts and laws, gravity and electromagnetism appear strictly analogous to each other. Now we turn to an important difference of the two interactions, in fact exactly *that* difference which is the reason why they seem to be incompatible in the usual view. As follows:

In the case of gravity, the radial metric change of the continuum results in a radial metric flow, which is *accelerated* towards the center. This acceleration itself corresponds already to the Newtonian approximation. The complete concept of gravity contains additionally also the assumption of waves in the accelerated flow.

Therefore, gravity acts *through the accelerated flow itself*. In this sense it can be asserted that gravity *is* the accelerated flow.

In the case of electromagnetism, the transversal (here circumferential) metric change of the continuum results in a metric flow that rotates around the center. This flow increases with decreasing distance from the center, however it is *constant* for any specified distance.

Therefore, electromagnetism *cannot act directly via the flow.*

So *how* does it work? – There is actually only one possibility: its effects must be mediated by waves that occur in connection with the respective metric-dynamic field, which means: by electromagnetic waves. Apparently, this corresponds to the usual notion of the interaction.

(However the interpretation changes in accordance with the assumptions of the local and objective interpretation of quantum mechanics presented in Chapter 7. There, the Photoelectric Effect and the Compton Effect were described by the simplest model of such an interaction. The main point was: photons are *not* particles. With respect to electromagnetism, this means: the "virtual" photons have no equivalent in the reality – everything follows from superposition of waves.)

With this, it is also explained why the electromagnetic interaction can be isolated, whereas this is impossible with gravity: The paths of the waves, through which the electromagnetic interaction is mediated, can be interrupted.

But this does not apply to the flow: it comes *before* anything that exists, such that it flows through everything. Thus it cannot be shielded. This is also the reason why, even in the case of total electromagnetic isolation, nonetheless in the charge-free space observable phase-shifts of electron matter waves occur: this is exactly the effect which must be expected due to the rotating flow of electromagnetism. And since, as mentioned just before, gravity *is* the flow, it is evidently impossible to isolate it.

Thus, the different mechanism of action of the two interactions follows directly from their definition. In spite of their common origin in the fundamental law (1), the one manifests itself directly as metric acceleration, whereas the other one is mediated by metric waves..

9.10. The Purpose of the Subsequent Considerations

I shortly interrupt the train of thought to point out what exactly the purpose of the whole action is.

It is neither about establishing a theory that is in competition with quantum mechanics, nor about deriving quantum mechanics once again. As with the interpretation of quantum theory in Chapter 7, also here it is intended to reconstruct the experiences, which gave rise to the theory, from a different point of view, in order to interpret them differently based on this reconstruction and, in this way, to *understand* them.

Due to the simplicity of the resources used, in some cases the results of the following sections correspond to those of the "old" quantum theory, which mainly Bohr and Sommerfeld contributed to. However for the intended target, this is not a disadvantage; on the contrary – precisely in this way we are returning to the original historic scene, so to speak exactly at the spot where the physics that had developed from experiences with everyday objects hit the atomic facts and was not able to interpret them – or say: could only describe them by a mathematical scheme at the price of losing any possibility of understanding what is actually going on there.

If we now arrive at this very point on our way, the situation is completely different: We are not equipped with models, the concepts of which originate from mechanics and must necessarily fail here, but with the concepts flow and metric, and it will turn out that, on this basis, the atomic facts either follow almost by themselves or at least can be deduced in an altogether understandable way.

Think e.g. about the question of the "permitted paths" or states. In the historical development, Bohr decided this question at first so to speak "via enactment", before de Broglie explained it by assigning wave-attributes to the particles – where however the term "explanation" seems problematical, because this is again the step into absurdity: into dualism, uncertainty etc.

In the metric dynamic model, these "permitted paths" are a matter of course.

Moreover, it is evident that there are *actually* no "paths" – the particle does indeed not exist – and that, accordingly, in the case of states with angular momentum 0 nothing at all rotates. (Such states could not be represented in the Bohr-Sommerfeld model.)

Also the connection between angular momentum and number of node surfaces of the respective state, which is unexplainable within the frame of post-mechanical concepts, can easily be derived and understood on the basis of our assumptions.

Basically, it is an analogy to the connection between momentum and inverse wave-length that was cleared up in Chapter 7 using the examples of the Photoelectric Effect and the Compton Effect. In the same way as could be seen there why and how momentum is connected with propagating waves, it can be understood here why angular momentum must be assigned to spherical harmonics.

Also the quantization becomes evident, and at the same time the fact that it appears in the form of integer multiples of a fundamental unit.

The spin can be reconstructed and understood in the metric dynamic model too, and the same applies to the three other quantum numbers.

As last point of this short preview, it should be mentioned that all these reconstructions can be carried out for any atomic number.

How will the reconstructions be performed? By using the metric-dynamic description of the field of a positive charge $\mu > 0$ in order to determine the possible stationary wave states within this field.

9.11. States of the Hydrogen Atom

(We continue to refer to the relativistic reference system at rest relative to O as S', the reference system moving with the rotating flow as S_F. Since under the conditions of the hybrid system, the arch differentials of S_F and S'_F are identical, the designation S'_F is omitted.)

So let S' be the system at rest with respect to a central positive charge $\mu > 0$. Let S_F be the system whose points rotate around O with speed w(r). (S_F is the flow system.)

For the determination of possible stationary wave states in the field of a positive charge $\mu > 0$ the following facts are required:

a) $$r\,d\varphi' \;=\; r\,d\varphi\,\left(1 - \frac{\mu}{r}\right)^{-\frac{1}{2}}, \quad dt' \;=\; dt\,\left(1 - \frac{\mu}{r}\right)^{\frac{1}{2}}$$ (see (18) and (19))

b) $$r\,d\varphi_F \;=\; r\,d\varphi\,\left(1 - \frac{\mu}{r}\right)^{-1}$$ (see (12), φ_F corresponds to φ')

c) $$w(r) \;=\; \pm c\sqrt{\frac{\mu}{r}}$$ (see (15))

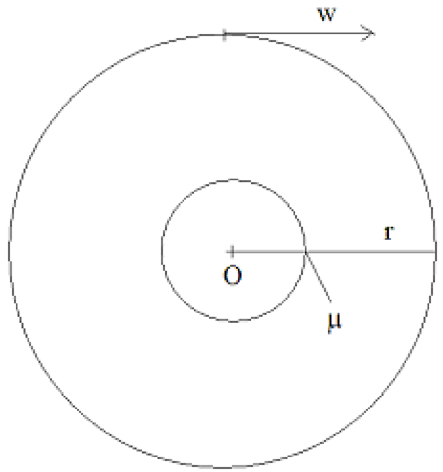
For the circumference U'(r) of a circle with radius r, measured in the system S', according to a) applies

$$U'(r) \;=\; 2\pi r\,\left(1 - \frac{\mu}{r}\right)^{\frac{1}{2}}$$

With respect to S_F, according to b) this circle has the circumference $U_F(r)$

$$U_F(r) \;=\; 2\pi r\,\left(1 - \frac{\mu}{r}\right)$$

Here is an outline. It shows an arbitrary plane through O. For w, one of the two possible directions is chosen:



(S3)

So much for the prerequisites as regards the field.

(In the following, the factor k again stands for: $k = \sqrt{1 - \frac{w^2}{c^2}} = \sqrt{1 - \frac{\mu}{r}}$)

As further prerequisite, the following fact is needed that we derived in Section 9.3:

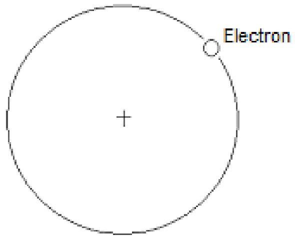
The existence of a particle is associated with the appearance of an in-phase oscillation on the surface of a sphere, the frequency of which is equal to the frequency f of the particle.

(f is the frequency that in standard physics is linked to the energy E of the particle by the equation $E = h\ f$)

Now we look at an electron. Let the geometric mass be m_e and the associated frequency f_e .

We imagine this electron placed in the field of a positive charge μ.

At first it must be cleared up what it means, seen from our viewpoint, "to place an electron into the field of a positive charge μ". Here, the electron is not a "particle" in the usual sense, because there are only metric alterations, flows and waves. Therefore it would be inappropriate to apply a mental image like in Bohr's atomic model:



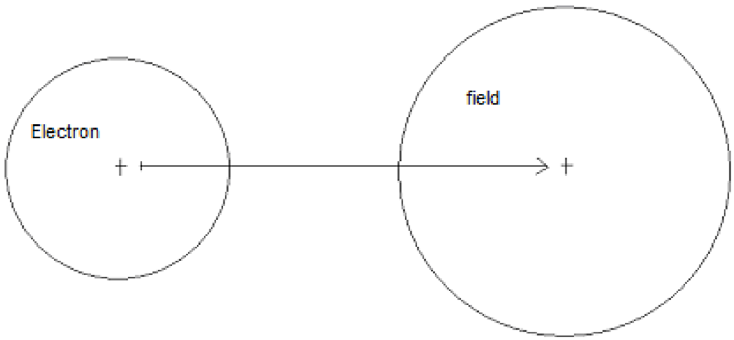
(S4)

– which means: to let the electron circle around the atomic nucleus.

Instead, exactly as in Chapter 7 on quantum theory, we act the following assumption – or let's say: working hypothesis:

The electron is an oscillation state of an area of the metric continuum.

Placing the "electron" in the field of a "proton" then means connecting the two states of the continuum, that is: to superimpose one on the other, as indicated in the next outline:



(S5)

So the question to be answered is:

What follows with respect to the in-phase oscillation on the spherical surface associated with the existence of the continuum state called "electron", if this state is superimposed upon an area of the continuum that is altered by a geometric charge $\mu > 0$?

The following sections will show whether our assumption regarding the electron is suitable.

In the first step, it will lead us to the ground state of the hydrogen atom.

The Ground State

Let us first discuss the conditions of the field by looking at an arbitrary plane through O. The "electron" is in the field. This means: in this plane an in-phase oscillation exists on a circle around O.

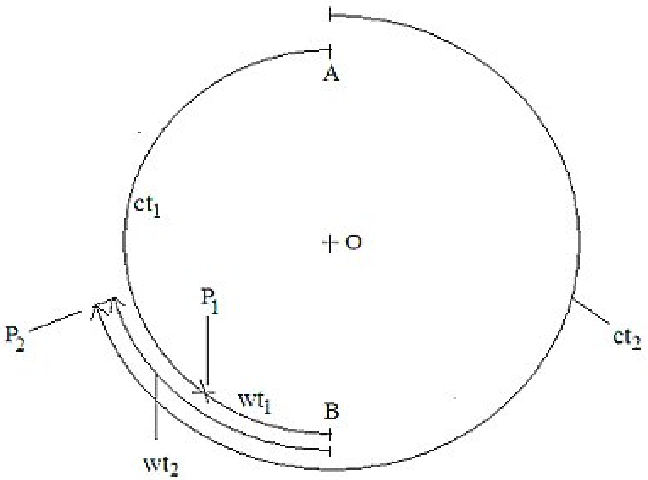
With respect to the rotating flow-system S_F, the phase coincidence of the oscillation is canceled, that is: with respect to S_F a *phase wave* exists. The wave-length of this phase wave provides for the condition, from which then ensues the radius r_1 of the simplest stationary oscillation state of the electron.

This condition reads as follows:

With respect to the flow system S_F, the wave length of the phase wave is equal to the circumference of the circle with radius r_1.

To determine the phase differences with respect to S_F, this time we will not use the Lorentz transformation (as we did with gravity), but instead resort directly to the relativistic definition – or better: *generation* – of time by means of processes with light speed, which we established in Section 3.1 and carried out in Chapter 6.

The following outline serves to illustrate the conditions from which the time shifts can be determined that apply for an observer in S_F, i.e. for an observer who rotates with the flow, compared to an observer at rest in S':



(S6)

From A, light signals are emitted into both tangential directions. If they propagate along the circle, they arrive simultaneously at an observer in S', who is resting at B. At an observer in S_F, who, at the time of the emission of the signals, is also at B and moves with velocity w along the circle, the one light signal arrives at point P_1 at the time t_1, the other one at P_2 at the time t_2. *Therefore, with respect to the moving observer, the time points of the emission of the signals differ by* $\Delta t = t_2 - t_1$.

The time difference Δt corresponds to the phase shift per circumference with respect to the moving observer.

As can be seen in (S6):

$$ct_1 + wt_1 = U_F/2 \qquad ct_2 - wt_2 = U_F/2$$

$$\Delta t = t_2 - t_1 = \frac{U_F/2}{c - w} - \frac{U_F/2}{c + w}$$

It follows $\quad \Delta t = U_F \frac{w}{c^2} \left(1 - \frac{w^2}{c^2}\right) = U_F \frac{w}{c^2} \frac{1}{k^2}$

Because of $\quad U_F(r_1) \;=\; 2\pi\, r_1 \left(1 - \frac{\mu}{r_1} \right) \;=\; 2\pi\, r_1\, k^2$

applies $$\Delta t \;=\; 2\pi\, r_1 \frac{w}{c^2} \tag{21}$$

This time difference must be set equal to one period of the oscillation. Since light moves *in the flow,* in any S_F the local light speed is always the same, and therefore the local time is identical with the time outside of the field and not retarded according to (19). Accordingly, with respect to S_F the frequency of the oscillation is f_e – i.e. the frequency of a free electron – and the period is $1/f_e$.

With this, the radius r_1 can be derived. We start with

$$\Delta t \;=\; 1/\, f_e \tag{22}$$

$$2\pi\, r_1 \frac{w}{c^2} \;=\; \lambda_{Ce} \frac{1}{c}$$ (λ_{Ce} is the Compton wave-length of the electron: $f_e \lambda_{Ce} = c$)

$$2\pi\, r_1 \;=\; \lambda_{Ce} \frac{c}{w} \tag{23}$$

$$r_1 \;=\; \bar{\lambda}_{Ce} \frac{c}{w} \tag{23'}$$

With $\quad \frac{c}{w} \;=\; \sqrt{\frac{r_1}{\mu}} \quad$ follows

$$\boxed{\, r_1 \;=\; \frac{\bar{\lambda}_{Ce}^{\;2}}{\mu} \qquad (24) \,}$$

Here, $\bar{\lambda}_{Ce}$ is the geometric mean of r_1 and μ. (Compare (8) and (8"))

If now the geometric charge μ is set equal to the classical electron radius r_e

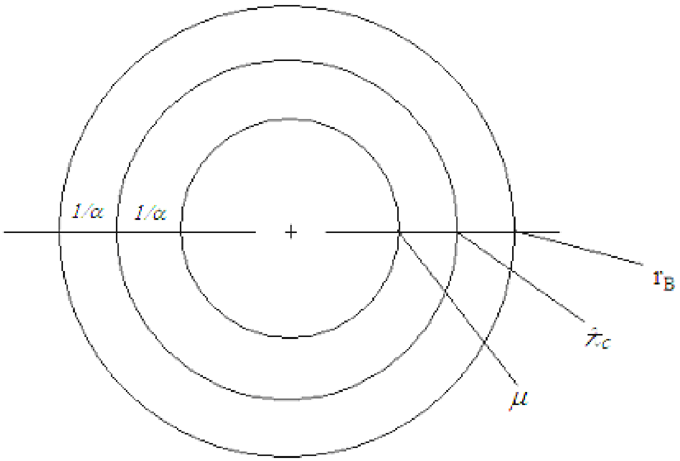
$$\boxed{\mu = r_e \qquad (25)}$$

– then r_1 is equal to the Bohr-radius r_B, and (24) turns into the well-known equation

$$\boxed{r_B = \frac{ƛ_{Ce}^{\ 2}}{r_e} = ƛ_{Ce}\frac{ƛ_{Ce}}{r_e} = ƛ_{Ce}\frac{1}{\alpha} \qquad (24')}$$

Therefore, because of (25), μ becomes the ***geometric elementary charge***.

Here is a (logarithmically scaled) outline of the conditions in the tangential flow w:



(S7)

In the metric dynamic model, the relationship between the three quantities classical electron radius (which here is the geometric elementary charge μ), the Compton wave-length of the electron and the Bohr radius is mediated by the rotating metric flow.

Up to now, our description was limited to the conditions on a plane.

However, anything hitherto derived applies to *any* plane through the center. This means that an in-phase oscillation – with a frequency that will be determined in the next section – exists not only on a *circle* with radius r_B around O, but on a *spherical surface* with this radius.

If an electron is positioned into the field of a positive charge μ, then a state results in which there is an in-phase oscillation on a spherical surface whose radius is equal to the Bohr radius.

The question is: Does this state correspond to the ground state of hydrogen?

This depends on the extent to which the attributes of this state, which ensue from the metric dynamic field definition, correspond to the known attributes of the ground state.

So let us determine further attributes of this state.

The Frequency of the Ground State

From the metric dynamic point of view, the frequency f_e' of the oscillation at the distance r_B (which is in-phase with respect to S') follows from the fact that in S' the time at the distance r_B is retarded by the factor

$$k = \sqrt{1 - \frac{w^2}{c^2}} = \sqrt{1 - \frac{\mu}{r_B}}$$ (see (19) and the related comments)

Therefore to this frequency – let us call it f_e' – applies

$$\boxed{f_e' = f_e\, k \qquad (26)}$$

The standard value f_e' of the electron in the ground state of hydrogen is

$$f_e'/f_e \;=\; 1 - \frac{\alpha^2}{2} \tag{27}$$

Let us compare $f_e'/f_e \;=\; k \;=\; \sqrt{1-\frac{\mu}{r_B}}$ with this value:

It holds that $\frac{\mu}{r_B} \;=\; \alpha^2$, and therefore

$$\boxed{f_e'/f_e \;=\; \sqrt{1-\alpha^2} \;=\; 1 - \frac{\alpha^2}{2} + \frac{\alpha^4}{8} - \;..... \;\approx\; 1 - \frac{\alpha^2}{2} \qquad (28)}$$

The metric dynamic value of f_e'/f_e in (28) is slightly different from the standard value in (27) ($\alpha^4/8 \;=\; 3.54 \;\; 10^{-10}$). Here, the standard value appears as non-relativistic approximation.

The Spin in the Metric-Dynamic System

To any point P on the spherical surface with radius r_B, where an in-phase oscillation with frequency $f_e' = f_e\,k$ exists, must be assigned the velocity $w(r_B)$ *at any direction* on the tangential plane defined by P. (See Section 9.6.)

On any plane through the center of the sphere, there are exactly two possibilities regarding the flow-velocity w(r) at the distance r_B:

$$w \;=\; c\sqrt{\frac{\mu}{r_B}} \qquad \text{and} \qquad w \;=\; -\,c\sqrt{\frac{\mu}{r_B}}$$

The fact of a rotation at any plane, the whose magnitude is fixed and which has exactly two possibilities, corresponds to the definition of the spin.

Therefore, we will use the flow-quantity $w(r_B)$ for the definition of a quantity that represents the metric dynamic analogue to the spin of quantum mechanics.

The quantum mechanical spin has the dimension of an angular momentum Θ, where

$$\Theta \quad = \quad M\, r\, w \qquad \text{(M is the "normal" mass in kg, w is the tangential velocity)}$$

In the metric dynamic system, there are only lengths and times and no other measures. Instead of introducing further unities, we define the metric-dynamic spin S_{md}, analogously to the "normal" spin (see also the deliberations in the Addendum at the end of this chapter):

$$S_{md} \quad = \quad m_e\, r_B\, w_{r_B} \quad \text{(}m_e\text{ geometric mass of the electron)}$$

$$w_{r_B} \quad = \quad \pm\; c \sqrt{\frac{\mu}{r_B}}$$

$$S_{md} \quad = \quad \pm\; m_e\, r_B\, c \sqrt{\frac{\mu}{r_B}} \quad = \quad \pm\; m_e\, c \sqrt{\mu\, r_B}$$

According to (24) $\quad \sqrt{\mu\, r_B} \;=\; ƛ_{Ce}$

Therefore $\quad S_{md} \;=\; \pm\; m_e\, c\, ƛ_{Ce}$

From (8") follows $\quad m_e\, ƛ_{Ce} \;=\; ƛ_{Pl}^{\;2}$

However, it must be factored in that (8") follows from (6), and that (6) was derived from the non-relativistic value for v (the gravitational metric flow velocity), which is $\sqrt{(m/r)}$. Since for deriving the spin a relativistic approach is necessary, here for v the relativistic value must be chosen, i.e. $v = \sqrt{(2m/r)}$. (Compare equation (9) from Chapter 4.)

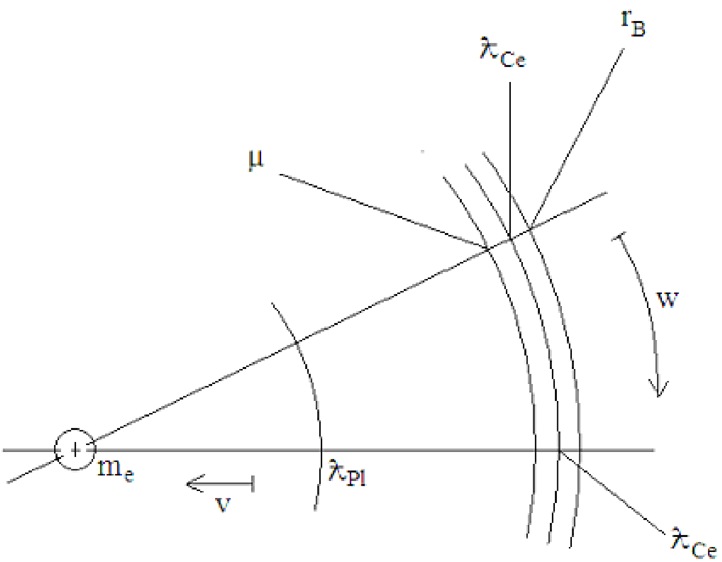
This means: when deriving (6), m must be replaced by 2m. Thus instead of (8") applies $2m_e\, ƛ_{Ce} \;=\; ƛ_{Pl}^{\;2}$, so that eventually follows

$$S_{md} \;=\; \pm \tfrac{1}{2}\, c\, ƛ_{Pl}^{\,2} \qquad (29)$$

The dimension of the action W is $kg\, m^2\, s^{-1}$. For the metric-dynamic analogon W*, kg must be replaced by meter; The dimension of W* is therefore $m^3\, s^{-1}$. Thus the right side of (29) has the dimension of the metric-dynamic action. With this, (29) assumes the following form and accordingly corresponds to the well-known equation

$$S_{md} \;=\; \pm \tfrac{1}{2}\, W^*_{Planck} \;=\; \pm \tfrac{1}{2}\, \hbar^* \qquad (29')$$

At the derivation of (29), it can be seen how at first the relation between the three quantities [m_e | $ƛ_{Pl}$ | $ƛ_{Ce}$], which is mediated by the *gravitational* radial metric flow v(r), and then the relation between the three quantities [μ | $ƛ_{Ce}$ | r_B], which is mediated by the *electromagnetic* tangential metric flow w(r), together make it possible to trace back the spin to the fundamental action:



(S8)

The outline (S8) is logarithmically scaled (but still not true to scale).[51]

As a reminder: According to (9') applies

$$m_e Z'_E \;=\; ƛ_{Pl} \qquad \text{and} \qquad ƛ_{Pl}\, Z'_E \;=\; ƛ_{Ce} \qquad \text{with} \quad Z'_E \;=\; 2.390\;\; 10^{22}$$

– and, according to (24) and (24')

$$\mu\;\; 1/\alpha \;=\; ƛ_{Ce} \qquad \text{and} \qquad ƛ_{Ce}\;\; 1/\alpha \;=\; r_B \qquad \text{with} \quad 1/\alpha \;=\; 137.036$$

Interpretation of the Spin

Now we will investigate the meaning of the fact that there is a rotation *on any plane* through O, whose value is fixed and for which there are exactly two possibilities.

Let us briefly return to the first law. It reads: $\dfrac{d\sigma}{dr} \;=\; \pm\, \dfrac{1}{c^2}\,\dfrac{dv}{dt}$

I said at this point: "This is the law, from which reality is woven."

Although this is expressed poetically, it is still meant to the point: *for us,* this law acts *in* space, but *in itself,* there is no such space – the continuum arises only through the action of this law, it is *actually woven from it.*

In the case of gravity, the development process is *1-dimensional:* the continuum is composed of *flow lines*. Let us again look, for the sake of simplicity, at the spherically symmetric case. Here, the continuum consists of radii – of rays that emanate from the center (or end in it). To these radii, certain metric attributes are assigned, and to the points located on them the according flow velocities. The condition, which is imposed on these one-dimensional regularities, is consistency:

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51 Actually, the half-integer spin becomes understandable only through the metric-dynamic approach: the concept of variable angle density allows to understand that a rotation of 360° is not necessarily sufficient to restore the original state. For a negative charge $\mu < 0$, the circumference of a circle with $r = |\mu|$ equals $4\pi|\mu|$, so that a full circle corresponds to an angle of 720° – and this is exactly the fact that is linked to spin ½ in quantum mechanics.

the 3-dimensional continuum, which is formed from these 1-dimensional laws, must not contain contradictions.

Since electromagnetism is assigned to the metric angle density, here the construction is *2-dimensional:* the continuum is composed of *surfaces* that go through the center O – let us call them M-surfaces. Therein is nothing peculiar, it is just as natural as composing the continuum of lines.

In the spherically symmetric case, the surfaces are planes through the center. To these planes again metric attributes are assigned, and to the points located on them flow velocities. The condition is again that no inconsistencies must occur in the composition of the planes to a three-dimensional continuum.

If these M-surfaces through O are composed to a 3-dimensional continuum, then other surfaces emerge – say R-surfaces (in the spherically symmetric case, they are spherical surfaces) –, which are defined by the condition that to any point on the surface the same flow velocity is assigned, in fact *in any tangential direction* on the surface.

The point, which is decisive for understanding this statement, is the fact, that it is a *statement about the continuum.* As such, it is neither absurd nor contradictory: it is just about assigning velocities to points. Actually, *nothing* moves – a point of the continuum is not an abstraction of something existing.

However, if one tries to interpret the velocity and the according rotation as *attribute of an object* – as is usually done in order to demonstrate the impossibility to understand quantum mechanical quantities other than mathematically – then the circumstances turn into absurdities, and, accordingly, it would indeed be proven that quantum mechanical objects are inaccessible to our thinking.

From the metric dynamic viewpoint, the following applies:

In the case of electromagnetism, the continuum consists of R-surfaces, to any point of which is assigned a flow velocity at any tangential direction. The surfaces are defined by the fact that the absolute value of this velocity is identical for all points of the surface.

These circumstances represent *attributes of the continuum.* They are *not* attributes of an object.

However the metric dynamic attributes of the continuum defined in this way now represent the necessary condition for the development of stationary wave states.

Only these wave states can be understood as "objects". Thus they contain the flow velocity not *as attribute,* but *as precondition.*

In the above section The Ground State, these facts can be seen clearly. There, an in-phase oscillation exists on the surface of a sphere. This oscillation state is the "object". The object has neither the attribute "flow velocity" nor does it rotate. Flow velocity and rotation are attributes of the continuum, and they are necessary conditions for the existence of the in-phase oscillation.

If one approaches the quantum mechanical objects coming from the side of *things,* then the only possibility is to interpret the quantities, which are needed for the description, as attributes of things – and to fail with this attempt at interpretation.

But if, on the contrary, one starts the description of the world with the *preconditions of being,* then one is at first confronted with the necessity to *reconstruct* things. The quantities needed for that do not yet belong to the realm of objects. Thus, from this viewpoint, it is evident that they are prerequisites and not attributes of objects.

Excited States: Quantum Numbers

In order to keep the reconstruction of the first quantum mechanical state as simple as possible and to highlight the metric dynamic substantiations, I described the inner spherical surface, where a phase coincidence occurs, a bit more in detail and separately from the outer surfaces with in-phase oscillations. Actually, however, this separation is not justified, since the derivation of the radii of these surfaces is analogous to the derivation of the Bohr radius, which has just been performed in the section "The Ground State".

Now we are looking for the radius r_n of the n^{th} spherical surface, where an in-phase oscillation exists, and for the frequency $f_e\,(r_n)$ of this oscillation.

Again we start with the fact that the in-phase wave state on the spherical surface – which is associated with the radial metric flow caused by the geometric mass m_e of the electron – is canceled through the rotating metric flow caused by the positive charge μ, so that with respect to the rotating system S_F a phase wave occurs.

The condition, which represents the basis of the calculation, is now that the circumference of the circle with radius r_n is, with respect to S_F, equal to n times the wave-length of this phase wave.

Let us begin with the phase difference Δt that occurs with respect to S_F. Analogously to (21) applies

$$\Delta t = 2\pi r_n \frac{w}{c^2} \tag{30}$$

However now instead of (22) $\Delta t = 1/f_e$

for the n^th spherical surface applies:

$$\Delta t = n / f_e \tag{31}$$

– because now the radius of the circle is to be determined, whose circumference is equal to n times the phase wave length, and therefore Δt must be equal to n periods of the oscillation. (Note that the phase wave exists only with respect to the rotating flow-system S_F; with respect to the non-rotating system S', there is no phase shift but again simply an in-phase oscillating spherical surface with radius r_n.)

With $\Delta t = 2\pi r_n \dfrac{w}{c^2}$ follows

$$2\pi r_n \frac{w}{c^2} = n \lambda_{Ce} \frac{1}{c} \qquad (\lambda_{Ce} \text{ Compton wave-length of the electron, } f_e \lambda_{Ce} = c)$$

$$2\pi r_n = n \lambda_{Ce} \frac{c}{w} \tag{32}$$

$$r_n \quad = \quad n\, ƛ_{Ce}\, \frac{c}{w} \tag{32'}$$

With $\frac{c}{w} = \sqrt{\frac{r_n}{\mu}}$ results

$$\boxed{r_n \quad = \quad n^2\, \frac{ƛ_{Ce}^{\;2}}{\mu}} \tag{33}$$

$$\boxed{r_n \quad = \quad n^2\, ƛ_{Ce}\, \frac{1}{\alpha} \quad = \quad n^2\, r_B} \tag{34}$$

The associated frequency $f_e\,(r_n)$ follows from

$$f_e\,(r_n) \;=\; f_e \sqrt{1-\frac{\mu}{r_n}} \;=\; f_e \sqrt{1-\frac{\mu}{n^2 r_B}} \;=\; f_e \sqrt{1-\frac{\alpha^2}{n^2}}$$

$$f_e\,(r_n)\,/\,f_e \;=\; \sqrt{1-\frac{\alpha^2}{n^2}} \;=\; 1 \;-\; \frac{\alpha^2}{2\,n^2} \;+\; \frac{1}{8}\frac{\alpha^4}{n^4} \;-\; .....$$

Except for the terms of higher order $\frac{1}{8}\frac{\alpha^4}{n^4} -$ ..... , this is identical with the usual value:

$$\boxed{f_e\,(r_n) \quad = \quad f_e\,(1 \;-\; \frac{\alpha^2}{2\,n^2})} \tag{35}$$

n is the principal quantum number.

The hitherto described states are equiphase states. There is no rotation – the "orbital angular momentum" is 0. However there are also states with angular momentum ≠ 0. Now we turn to these states.

At first we must define the metric dynamic analogue L_{md} of the orbital angular momentum |L|. Analogously to the procedure with the spin, we define:

$$L_{md} \;=\; m\, r\, v_t \tag{36}$$

Here, m is again the geometric mass, r is the distance from the center of rotation, v_t is the tangential velocity (read v_t /c).

First, a preliminary consideration: The result of the previously performed derivation was that on a circle with radius $n^2\, r_B$ an in-phase oscillation exists, i.e. an oscillation without node points.

On this circle, however, also states *with* node points are possible – but only if these nodes *rotate* with respect to S'.

Let us assume, the velocity at which the nodes – in other words: the oscillation state itself – propagate along the circle, is $w(r_n)$. If we multiply (36) by k, then the left side of the equation represents the length of the circumference of the circle with respect to S', and the right side represents the number of the waves times the phase wave length:

$$2\pi\, r_n\, k \;=\; n\;(\, \lambda_{Ce}\, \frac{c}{w_{(r_n)}}\; k\,)$$

This means: If the velocity of the node points is equal to the rotation speed of the flow $w(r_n)$, then follows that, with respect to S', a phase wave exists with n wave lengths per circumference. (With respect to S_F, the oscillation is in-phase.)

In general, the following applies: The wave-length of the phase wave in a resting system, which, due to the Lorentz-Transformation, emerges from an in-phase oscillation with frequency q in a system moving at velocity v, is equal to $(c/q)\,(c/v)\; k$. From this follows, that the wave-length is approximately inversely proportional to the velocity v. (Only approximately, since k depends on v.)

Therefore, if, at a rotation speed equal to the flow velocity $w(r_n)$, the number of waves per circumference is equal to n, then, for a phase wave with *one* wave per circumference, a rotation speed of $w(r_n)/n$ is needed.

And thus, finally, the precondition for the existence of a phase wave with l waves per circumference is, that the speed v_t at which the nodes rotate, must be equal to $l\,w(r_n)/n$.

Let us now substitute in $$L_{md} = m\, r\, v_t \qquad (36)$$

For the geometric mass m must be set m_e, r is r_n, $v_t = l\,w(r_n)/n$

This leads to: $$L_{md} = m_e\, r_n\, l\, w(r_n)/n$$

It applies $$r_n = n^2 r_B, \quad w(r_n) = \sqrt{\frac{\mu}{n^2 r_B}}$$

From this follows:

$$L_{md} = m_e\, n^2 r_B\, l \sqrt{\frac{\mu}{n^2 r_B}}\, \frac{1}{n}$$

$$L_{md} = l\, m_e \sqrt{\mu\, r_B} \qquad [\, \mu\, r_B = \lambda\!\!\!^-{}_{Ce}{}^2 \qquad (24)\,]$$

$$L_{md} = l\, m_e\, \lambda\!\!\!^-{}_{Ce} \qquad [\, m_e\, \lambda\!\!\!^-{}_{Ce} = \lambda\!\!\!^-{}_{Pl}{}^2 \qquad (8'')\,]$$

And therefore, finally:

$$\boxed{L_{md} = l\, \lambda\!\!\!^-{}_{Pl}{}^2 \qquad (37)}$$

l is the orbital angular momentum quantum number.

As with the spin (see (29)), also here $ƛ_{Pl}{}^2$ can be replaced by the metric-dynamic action ħ* (see the associated note in the *Addendum*):

$$\boxed{L_{md} \quad = \quad l\, ħ^* \qquad\qquad (37')}$$

For comparison: The quantum mechanical value of the orbital angular momentum is

$$|L| \quad = \quad (l\,(l + 1))^{1/2}\, ħ$$

There is a fundamental difference between spin and orbital angular momentum: The spin is an ***attribute of the continuum*** (in the neighborhood of a geometric charge) and, therefore, a *precondition* of the oscillation state that we understand as the "object". In contrast, the orbital angular momentum follows from the assumption, that *the oscillation state itself* rotates, which means: it is an ***attribute of the object***.

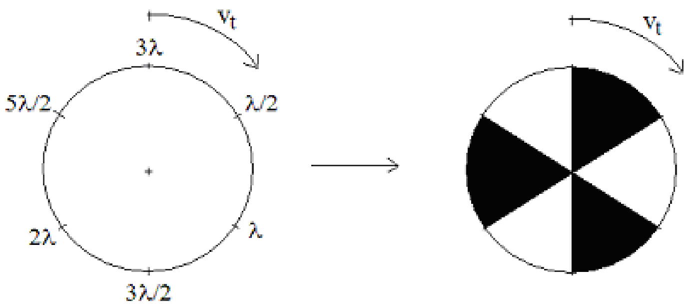
In the case of a state *without* orbital angular momentum, it is possible to assemble the in-phase oscillations along the circles with radius r_n at all planes through O to a total in-phase oscillating spherical surface.

However in the case of a state *with* orbital angular momentum ≠ 0, there are node points, which move along the circumference with the velocity $v_t(l)$. If one now assumed the same rotation at all planes through O, it would be impossible to assemble the circles on all planes to an oscillating spherical surface.

This means: In the case of a state with orbital angular momentum ≠ 0, at the transition from the circle-oscillation to the spherical surface-oscillation, the spherical symmetry of the continuum-state is broken. Other than the spin, which is an attribute of the spherical symmetric continuum-state and has therefore the same value with respect to *any* plane or of any rotation axis, the orbital angular momentum is an object attribute and exists therefore always only with respect to a given direction.

Based on the hitherto performed conclusions, we have arrived at the idea of a spherical surface on which there is a wave with *l* nodal lines, and which, at the same time, rotates in a definite direction.

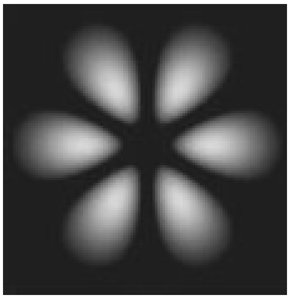
As an example, here is an illustration of the state with n = 4 and $l = 3$:



(S9)

Here, if one proceeds from the view at a plane (to the left) to a spatial view (to the right). then the oscillation state of the circle turns into the oscillation state of a spherical surface, which rotates with the tangential velocity $v_t(l)$. The 6 node points along the circle turn into 3 node lines on the spherical surface. The areas of positive amplitude values are displayed in black, the areas of negative values in white.

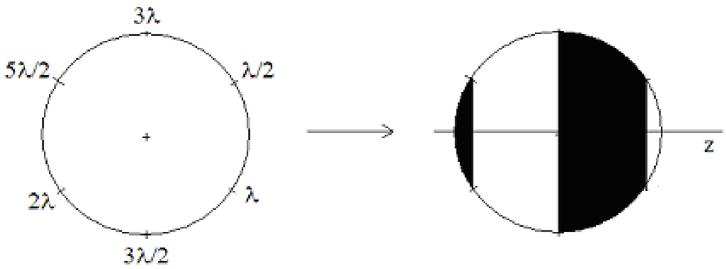
The angular momentum of the state on the right side of the outline corresponds to the angular momentum of the quantum mechanical 4f-state depicted in the following outline:



(S10)

(In (S10), all oscillation areas appear white, because here the squares of the amplitudes of the wave function are depicted.)

The transition from the oscillating circular line to the oscillating spherical surface can also be carried out in another way as in the outline (S9) – e.g. as in this way:

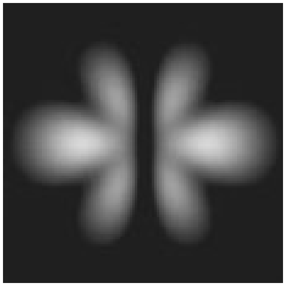


(S11)

Here, all planes defined by node lines are parallel to each other and normal to a given direction. In the outline, this is the direction parallel to the arrow. Let us call this direction z, as usual. From the derivation of (37) follows that the rotation speed is proportional to the number of the nodes, which occur on the plane through O and normal to the rotation axis. Since in (S11) the number of the nodes on the plane through O and normal to z is equal to 0, there is no rotation with respect to z.

This leads us to the *fourth quantum number m:*

m denotes the number of the planes which are defined by node lines and which are *not* normal to z. Thus, in (S11), $m = 0$, and the state on the right side of the outline (S11) can be identified with the 4f (m=0) state in the following outline:



(S12)

(Also here all oscillation areas appear white, because the outline shows the squares of the amplitudes of the wave function.)

At any given number of nodes l, the number of possible m-states must be equal to $2l + 1$; it follows directly from the number of the possibilities, to arrange – in the case of l node lines in total – m of the planes defined by them in parallel to each other and normal to z, and from the fact that, for $m \neq 0$, there are always two rotation directions with respect to z.

The speed at which the spherical surface rotates around the z-axis – and the according angular momentum – depend on the number of the planes defined by node lines, which are not normal to z. Thus the angular momentum with respect to z depends on m.

This corresponds to the quantum mechanical rules.

The general scheme is evident: the total number of nodes is determined. At the transition from the view at a plane to a spatial interpretation, the symmetry of the continuum state is broken, and the possible oscillation states of a spherical surface with l node lines must be determined.

In this way, the orbital angular momentums of all quantum mechanical states of the hydrogen atom can be constructed..

Up to now, we have only investigated the phase conditions on planes with radii $n^2 r_B$, which are characterized by the fact that the phase wave interferes *constructively.* However it is evident that the phenomenon "electron in the field of a positive charge μ" is a *three-dimensional* oscillation state.

So let us at last take a look at the "inside" of a state A, which is characterized by the quantum numbers n_A, l_A.

The surfaces with radii $n^2 r_B$ ($1 \leq n \leq n_A$) must be understood as those surfaces where the amplitude of the three-dimensional oscillation state has its maximum. In the case of the state A, the surface with radius $n_A^2 r_B$ is obviously the outermost of these surfaces.

How many such surfaces with maximum amplitude are there within the state A? At first it appears as if the answer were simply $n_A - 1$. However the following consideration shows that, for $l_A > 0$, not all spherical surfaces with radius $n^2 r_B$ are permitted. As follows:

The (metric-dynamic) angular momentum of A is $l_A \, ƛ_{Pl}^{\,2}$. Thus it depends only on l_A. We derived it from the phase conditions on the outermost spherical surface. It must be assumed, however, that the same value of the angular momentum applies also to all other spherical surfaces with maximum amplitude.

As was shown at the derivation of (37), $l_A w(r_n)/n$ represents the rotation velocity of the spherical surface with radius r_n. With $l_A = n$, this velocity would be equal to $w(r_n)$, and it can easily be shown that the frequency on this plane would then be equal to f_e, i.e. to the frequency of a free electron, which is not permitted.

Therefore, the condition must be met: $l_A < n \;\; (1 \le n \le n_A)$.

From this follows that only $n_A - l_A$ surfaces of the n surfaces with $n^2 r_B$ can have a rotation velocity, which leads to the required angular momentum.

In other words: in the state A, which is characterized by the quantum numbers n_A, l_A, there are $n_A - l_A$ spherical surfaces, where the amplitude is maximal.

Between these spherical surfaces with maximum amplitude, there must be *node surfaces.* Thus, the number of the inner spherical node surfaces is $n_A - l_A - 1$.

Since we determined the number of the node surfaces that are planes through the state $A(n_A, l_A)$ as l_A, we come to the result that $A(n_A, l_A)$ is a spatial oscillation state with $n_A - 1$ node surfaces in total, of which $n_A - l_A - 1$ are spherical surfaces that lie inside.

This corresponds to the quantum mechanical definition of the *orbital.* However, at the orbital, rotation and oscillation are so to speak "frozen"; this is a consequence of the time-independence of the underlying Schrödinger equation.

(In order to determine the radii of the inner node surfaces as well as the distribution of the amplitudes in general, it would be necessary, besides the condition of the spherical harmonics also to take into account the r-dependence of the amplitudes. But this will not be carried out here.)

9.12. Atoms with Nuclear Charge Number Z > 1

Finally, here are some remarks about the generalization of the previous results to the case of a positive charge $Z\mu$ ($Z \in \mathbb{N}$, $Z > 1$), i.e. to atoms with a nuclear charge greater than 1. I will be brief, because the construction scheme remains essentially the same.

In all derivations, which were performed for $Z = 1$, μ must be replaced by $Z\mu$.

Thus instead of $\quad w = \sqrt{\frac{\mu}{r}} \quad$ it must be set: $\quad w = \sqrt{\frac{Z\mu}{r}}$

At the derivation of the radius of the n^{th} in-phase oscillating spherical surface, in the general case applies, exactly as in the case of hydrogen (see equation (32')):

$$r_n = n \, \lambda\!\!\!^{-}_{Ce} \, \frac{c}{w}$$

With $\quad \frac{c}{w} = \sqrt{\frac{r_n}{Z\mu}} \quad$ follows

$$\boxed{\begin{aligned} r_n &= n^2 \, \frac{\lambda\!\!\!^{-}_{Ce}{}^2}{\mu} \, \frac{1}{Z} && (38) \\ r_n &= n^2 \, \lambda\!\!\!^{-}_{Ce} \, \frac{1}{\alpha} \, \frac{1}{Z} = n^2 \, r_B \, \frac{1}{Z} && (39) \end{aligned}}$$

In the case of states with angular momentum $\neq 0$ applies, as before:

$$L_{md} = m \, r \, v_t$$

$$m = m_e, \quad r = r_n = n^2\, r_B\, \frac{1}{Z}, \quad v_t = l\,w(r_n)/n = l \sqrt{\frac{Z\mu}{n^2 r_B \frac{1}{Z}}}\, \frac{1}{n} = l\,Z \sqrt{\frac{\mu}{r_B}}\, \frac{1}{n^2}$$

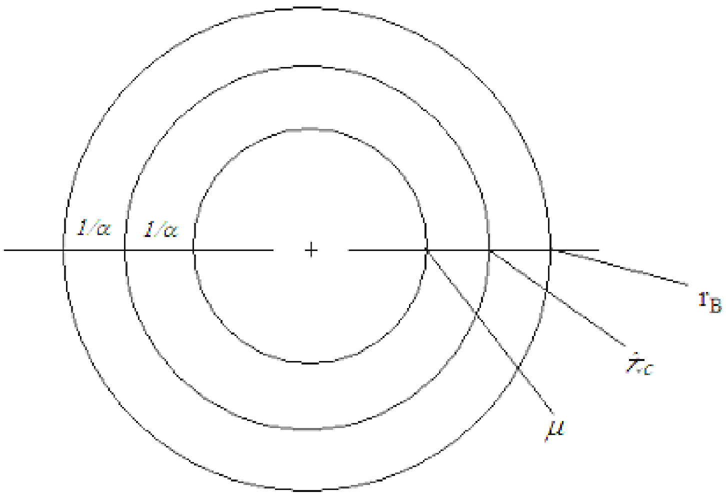
The factors Z cancel each other, and the result is again identical with (37)

$$L_{md} = l\ \lambdabar_{Pl}{}^2$$

Note:

It deserves to be mentioned that in the metric dynamic model can easily be demonstrated that nuclear charge numbers Z > 137 are probably not possible.

We look again at the logarithmically scaled outline (S7):



(S7)

$$\text{Here,}\qquad \lambdabar_{Ce}/\mu = r_B/\lambdabar_{Ce} = 1/\alpha$$

$\bar{\lambda}_{Ce}$ is the geometric mean of μ and r_B, i.e. of the geometric elementary charge and the radius of the innermost shell.

However this applies evidently to any geometric charge $Z\mu$ and any according radius r_B/Z of the innermost shell: with increasing Z, the geometric charge approaches the Compton wave-length of the electron from the inside, and the radius of the inner shell approaches the Compton wave-length from the outside; the Compton wave-length, however, remains always the geometric mean of the two quantities.

$1/\alpha = 137.036$, and therefore, with $Z > 137$, the geometric charge $Z\mu$ becomes greater than $\bar{\lambda}_{Ce}$. Then the innermost radius lies within $\bar{\lambda}_{Ce}$ and therefore also within $Z\mu$.

However within $Z\mu$, i.e. for $r < Z\mu$, the velocity of the rotating metric flow

$$w = c\sqrt{\frac{Z\mu}{r}}$$

is greater than c, and, consequently, there is no longer a static real metric – exactly as is the case with gravity in the area $r < 2m$.

Though this is not a completely compelling reason that a limit of the possible nuclear charge numbers is reached, it can still be asserted that with $Z > 137$ something essential changes. It seems therefore unlikely that the regularities that apply to the cases with $Z \leq 137$ hold true in the realm outside of this limit.

Note: The Compton wave-length of the proton $\bar{\lambda}_{Cp}$ is smaller than the geometric charge μ by the factor 13.399.

From this follows that the positively charged nucleus lies *always* inside the area of complex metric.

9.13. Interpretation: What is an Electron Shell?

What is the "electron shell" of an atom?

The metric-dynamic answer has been given already in Chapter 7 on quantum mechanics. In the current chapter, it has been completed and specified. It reads as follows:

The electron shell of a nucleus with charge number Z is a stationary oscillation state of a spatial area, in the center O of which a positive geometric charge Zμ is located. This charge creates a field, which is defined by a rotating metric flow and a metric change of the circumferences of circles around O. The field represents the necessary condition for the stationary oscillation state "electron shell".

The shell is complete, if its negative geometric charge amounts to −Zμ. Then the squares of the imaginary metric flow, which is connected with the negative charge of the shell, and of the real metric flow, which is connected with the positive charge of the nucleus, cancel each other out, and so do the metric alterations of the circumferences. The atom is then neutral

The interpretation of the electron shell as stationary oscillation state of a spatial area served in Chapter 7 as basis for the explanation of the *reduction of the wave function* and for its description as an ordinary physical process.

This hypothesis, whose strength was at first that it enabled a consistent and objective interpretation of quantum mechanics, has now twice been confirmed:

On the one hand because it was possible to reconstruct an important part of the basic physical reality exclusively by the quantities metric density and metric flow – from which evidently follows that locally confined physical phenomena ("particles") are to be interpreted as stationary states of changes of these two quantities, and on the other hand because we succeeded in deriving many known atomic facts under the assumption that electron shells are *in fact* wave states *and nothing else.*

This brings us to the next question: *What kind of waves are electron shells?*

Here, we constructed them as phase-waves of the Planck-waves, determined by the condition that they form standing waves. This condition appears two times: first it must be met in the longitudinal, radial metric flow, which is generated by the geometric mass m_e, and second in the transversal, rotating metric flow generated by the geometric charge Zμ. Only due to the cooperation of both conditions the spatial wave structure can develop that presents itself as electron shell..

The next question is: *What is actually oscillating?*

This has already been answered. The amplitude of the waves represents the velocity of the longitudinal or the transversal metric flow or, alternatively, the metric density of the length or the angle. (See the wave-equations (2), (2'), (3), (3') and (4) in Chapter 3.) [52]

The appearance of an "electron" is always connected with a local increase of the *angle density*. In the case of a "bound electron", the area of increased angle density is spherically symmetric, in the case of a "free electron", the greater angle density must be transported through space by the electron-wave. Presumably this means that the amplitude of the angle density does not oscillate around the value 1 but around a value greater than 1 – as opposed to light waves, where no altered angle density must be transported and where the mean value of the amplitude is therefore 1.

The hypothesis that the electron shell is a stationary state of "normal" waves has some important consequences. They have already been mentioned in Chapter 7. However I will recapitulate them briefly and formulate them more precisely on the basis of the recently derived facts.

"Electrons", just as "photons", are transitions between different possible spatial oscillation states in the field of the charge Zμ. The difference between both is that at the transition called "electron" the geometric charge changes, but not at the transition called "photon".

The transitions themselves – as always with standing waves – are indeed discontinuous, however only in the trivial sense, that the values of the quantities, by which the possible states are characterized, are not continuous but appear in discrete sequences. But the processes that cause the

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52 According to our construction, the phase wave structure *electron shell* actually contains both kinds of waves: those which belong to gravity as well as those of electromagnetism. In the orbital, they are matched to one another. This suggests that in the oscillation states of the electron shells the information is hidden about the relationship between the strengths of the interactions.

transitions are continuous – and this is exactly the same with electrons as with waves of any other kind.

In this regard, an electron can indeed be compared with an acoustic interval, which occurs at the transition between two states of a standing air wave in a tube and which therefore represents the difference between two tones.

Completely unsuitable, however, is the idea of an indefinable entity called "particle" that is "located" somewhere. (*What* should be located somewhere?) [53]

Thus, from the metric dynamic viewpoint, it does not make sense to speak of the "number of electrons" in the shell, which is limited by the fact that no electron must match another electron in regard to all quantum numbers. There are not $2n^2$ electrons per shell but $2n^2$ possible oscillation states.

With this, also the usual interpretation of the amplitude square of the wave function as "probability of the presence" of an electron becomes obsolete. However, this is by no means a loss: indeed, it is completely impossible to answer the question of *which physical entity* the probability actually refers to. The only possible answer would be: "To exactly *that* entity that is located there with this probability."

All that can be said beyond this nonsensical tautology is that the probability distributions of events, which are caused by the interaction with an electron, can be traced back to the distribution of the amplitude squares of the wave function of the electron.

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[53] Once again the acoustic analogy: electrons are in just the same sense "particles" or *not* particles as a standing wave in a tube consists of a number of particles or does not, or as the transition between one overtone to another overtone is a particle or not.

So if anyone wants to contend that an electron shell consists of a certain number of electron-particles, he/she can of course continue to use this designation – however consequently he/she should then also say that the oscillation state of the air in the tube that corresponds to the 5th overtone, consists of five particles, and that the transition from one overtone to another overtone is caused by a particle. And, above all, he/she should know that all these "particles" are by no means indivisible substantial entities but *gestalt phenomena,* which, under identical conditions, develop always anew in identical form.

However this connection is also substantiated by the pure wave interpretation, without going through the absurd detour over an entity "particle".

Let us assume e.g. that light is scattered on an electron-*particle*. Then the average scattering angle will be large where the amplitude square is large, because, in the usual interpretation, this means that the electron will be there with high probability.

But this is of course also true if the electron is interpreted as the whole *spatial oscillation state* and the amplitude is interpreted as angle density: where the periodic change of the square of the angle density is large, there also the average deviation of the light wave must be large.

And further: in the usual interpretation, the scattered photon causes, with a certain probability – which is again the square of a wave-amplitude – a transition that can be measured.

In the wave-interpretation, the squares of the amplitudes add up, until somewhere a transition occurs. The result is in both interpretations identical.

I can only repeat what I have already stated in Chapter 7:

Understanding the electron as particle leads to irreparable conceptual difficulties. The absurdities connected with it result ultimately in the loss of *any* interpretation – which, at present, is only masked by the fact that the currently prevailing combination of total conceptual void and formal and experimental know-how is called *interpretation,* though it surely does not deserve this denomination.

This state of affairs appears all the more unpleasant, as clinging to the notion of "particle" in the form of a substantial indivisible entity is actually completely superfluous.

9.14. Closing

I close the chapter on electromagnetism and forgo a summary: everything important has already been said many times.

On the one hand, it seems inappropriate and arbitrary to stop at this point – there are too many unanswered questions.

Above all, the description of the *actual* electromagnetic interaction is missing. However, the metric-dynamic prerequisites of the interaction have been established, and it would therefore be easy to define the acceleration of an object in the electromagnetic field as follows: proportional to the central charge $Z_1\,\mu$, to the charge of the test-object $Z_2\,\mu$, to $1/r^2$ and to 1/m of the object. ($\mu > 0$, $Z_1 \in \mathbb{Z}$, $Z_2 \in \mathbb{Z}$; m is the geometric mass.)

But such a description would be purely formal and therefore unsatisfactory. In electromagnetism, by contrast to gravitation, there is no accelerated flow and thus also no direct acceleration. Everything needed must follow either from the frequencies, lengths and phases of the waves,[54] or – and this would be the more attractive variant – the electric and magnetic field can be derived directly from the rotating metric flow-field. In both cases, I have not succeeded. However, I didn't try for very long – the desired goal had long since been achieved and I had far exceeded my expectations.[55]

On the other hand, it is completely justified to stop here. The main objective of this chapter is to derive known hypotheses by using only the quantities metric density and metric flow and to prove in this way, that it is possible to start the project *philosophy of nature* not from the observable phenomena but from the other side – from the metaphysical preconditions of being, and for this purpose also in this chapter more than enough evidence has been achieved.

Notes

1. The considerations of this chapter have confirmed the hypothesis put forward in Chapter 7: that quantum mechanics must be understood as a theory through which stationary wave states and their transition probabilities are described.

These stationary states are attractors of the local dynamics, i.e. they are the simplest possible local oscillation states. That's why quantum mechanics is simple. However, it is therefore also not

[54] If the interaction is to be described by waves, then there are two possibilities: The first one is to describe it simply as *superposition* of the waves. The velocity that results from the superposition represents the outcome of the interaction. Two examples of such a description by wave superpositions were performed in Sections 7.2 and 7.3 on the Photoelectric and the Compton Effect. The second possibility is to reduce the acceleration of an object in the field to the phase shifts of the waves in the field.

[55] Unfortunately, there was no reason later – such as the problem of galaxy rotation in the case of gravity – that would have motivated me to try an upgrade.

fundamental: the fundamental processes of creation, transition and decay of such states are not contained in it, but just presupposed.

However, quantum mechanics is perfectly suited for describing what happens on atomic scales, and perhaps it will never be possible to formalize the actual, causal realm of waves. It is the same here as e.g. in the case of standing air waves in wind instruments: the description of the frequencies of the partials is simple, and it is completely sufficient to describe what is audible (observable). However, the transition processes that lie between the different sound events are extremely complex, never completely the same and can perhaps be formalized in principle, but probably never in detail.

However, in order to understand what *really* happens when playing a wind instrument and why it happens, it is necessary to look at the entire dynamics – and exactly the same is true in the case of molecular and atomic events.

2. The fact that the usual description of the electromagnetic interaction (and all other interactions) is based on "exchange particles" can be explained from a metric-dynamic point of view just as easily as the fact of the (apparently) discontinuous transitions between the observable states of electron shells, which are called "photons".

In addition to the assumption that photons are nothing other than these transitions themselves (and not "particles"), also the assumption is required that a change in speed is always a change in frequency – which is self-evident in the wave model.

If two objects interact with each other, then this interaction must manifest itself as a change in frequency. This change is – as always – continuous, but observable – as always – is only the discontinuous transition to a different overall vibration state, which, according to the usual interpretation, is then again understood as the result of a "particle", i.e. the exchange particle.

3. In our view, the difficulties posed by the unification of gravity and electromagnetism are due to the fact that Einstein's theory of gravity (GR) is metric and the theory of EM is mechanical. As follows:

What is the reason why the frequencies of two identical particles, whose distances from a mass are different, differ from each other? One could name two reasons: the different passage of time and the difference in energy.

Ontologically speaking, however, for a basic fact there can only be *one* basic reason. From our point of view, this is the different passage of time. From it results the difference in frequencies, and only by *defining* energy proportional to frequency, the energy difference follows.

But what is the reason why the frequencies of two electrons that are at different distances from the nucleus differ from each other? From the usual point of view it can only be the energy difference, since EM takes place in the (given) spacetime and therefore the time does not change. But if one takes this standpoint, then the fundamental ontological difference between EM and G has been declared a fact, and therefore the two interactions cannot be united or can only be reconciled via absurd detours.

This difficulty disappears with our approach. In the metric-dynamic model, also in the case of electrons the *actual* reason for the frequency difference is the different passage of time. Both interactions are space-time phenomena, i.e. they are associated with changes in space-time.

Reality is woven *from one single law*, the one described by equation (1). This law has two interpretations: in one the longitudinal metric flow is linked to the metric density of length, in the other the transverse metric flow is linked to the metric density of angle; one interpretation leads to gravity, the other to electromagnetism. The phenomena currently summarized under the names gravity and electromagnetism are therefore states and processes into which reality organizes itself based on this single law.

In this picture, gravity and electromagnetism are unified because they arise from the same law. Both are based on space-time dynamics. At the same time, however, their differences become clear: Gravity is a phenomenon of the longitudinal flow and acts directly through the accelerated flow, electromagnetism is a phenomenon of the transverse or rotating flow and acts through waves.

4. As with the representation of gravity, also for the reconstruction of the quantum mechanical atom model we used exclusively metric facts – all explanations, justifications and derivations were purely metric. Since they inherit the causality of equation (1), they become part of the causal structure of the description of reality.

However, while in the case of gravity the connection to standard physics was established right at the beginning – through the equation $m = MG/c^2$, which is to be understood here as the defining equation for M, the mass in kilograms – with the atomic model we have remained completely in the realm of metric, except when comparing the respective results with the quantum mechanical specifications.

5. Finally, I would like to comment again on the unfinishedness and sketchiness of this chapter. I took it almost unchanged from the Concept of Reality. When I wrote my metric approach to the structure of the atom more than ten years ago, it was the continued amazement that such simple metric ideas could be used to recreate a mathematical model as complex as the quantum mechanical atom that motivated me to perform this reconstruction.

As already mentioned several times, at that time I was actually only interested in investigating whether my equations (0) and (1), which had arisen from metaphysical considerations, made any physical sense. I therefore perceived the agreement with the quantum mechanical specification as confirmation. It was only much later that I realized that this metric atom structure was not just a new approach to an already existing theory, but a step towards a completely new theory.

As described in the Preliminary Report, the reason for this change in my perspective lay in a different physical area: considerations about galaxy rotation showed me that my metric approach does not lead to GR, but to a new theory, and that this theory results in a significantly greater rotation speed than GR. This discovery motivated me so much that, after a long interruption, I resumed work on my description of gravity and developed it at least to the point where the differences from GR became clear.

I am now convinced that the changes in electromagnetism will be even more dramatic than in gravity if the outline presented here is developed into a theory. The theory of EM – even in its current form as quantum electrodynamics – is *pre-metric*, in this respect at the same stage in which gravity was before Einstein. From this point of view, the theory of EM is missing the decisive development step. (This of course also applies to the theories of strong and weak interaction.)

Expanding my concept into a theory would address this deficiency. And that is also the reason why I included this concept – despite its incompleteness – in my new book.

Addendum: Changeover to a Purely Metric-Dynamic System?

From the metric-dynamic perspective, the following applies:

1. The justification of a physical theory – e.g. the theory of gravity – is always purely metric. So there are only the dimensions length and time.

2. However, there is already a description that assigns the (experienced) properties *heaviness* and *inertia* (which in the metric-dynamic view are identical) their own, specific dimension *mass* with the unit kg.

3. This quality *mass*, which comes from experience, can be linked to the causal metric structure through a definition equation – here this is the equation $m = MG/c^2$.

But then the question arises:

Does the mass in kilograms still have a right to exist? Can't it simply be replaced *everywhere* by the geometric mass with the dimension length? – and by that I mean a *direct* replacement, i.e. without the dimensional factor G/c^2.

I want to first demonstrate this with a few examples.

(For the sake of consistency, I will mark the metric quantities that replace the standard quantities with *. So from now on, the geometric mass will be referred to as M^* instead of m as before. The dimensions will be expressed through the corresponding units.)

	Dimension of the mechanical quantity:	Dimension of the mechanical quantity:	
Force:	$\dim F = \text{kg m s}^{-2}$,	$\dim F^* = \text{m}^2\,\text{s}^{-2}$	
Energy:	$\dim E = \text{kg m}^2\,\text{s}^{-2}$	$\dim E^* = \text{m}^3\,\text{s}^{-2}$	
Action:	$\dim W = \text{kg m}^2\,\text{s}^{-1}$	$\dim W^* = \text{m}^3\,\text{s}^{-1}$	usw.

In all equations that contain the quantity *mass*, the dimension is changed by replacing [kilogram] with [meter].

The set of elementary measurement units is thus reduced.

The equations then change into formally identical equations. Here are some examples:

Newton's equation [force = mass times acceleration]

$$F = Ma \qquad \text{or, in differential notation:} \qquad F = d(Mv/dt$$

turns into

$$F^* = M^* a \qquad \text{or} \qquad F^* = d(M^* v)/dt$$

Obviously applies $\quad M^* = M \dfrac{G}{c^2}$

It follows that the metric-dynamic quantum of action h^* has the following relationship to the usual quantum of action h:

$$h^* = h \frac{G}{c^2} \quad (\dim h^* = m^3 s^{-1})$$

Then from $\quad E = h\nu \quad$ follows $\quad E^* = h \dfrac{G}{c^2} \nu \quad$ and $\quad E^* = h^* \nu$

For the elementary length λ_{Pl} applies:

$$\lambda_{Pl}^2 = \frac{hG}{c^3} = h \frac{G}{c^2} \frac{1}{c} = h^* \frac{1}{c}$$

Thus the metric-dynamic quantum of action h^* is equal to the square of the elementary length times the speed of light.

$$h^* = \lambda_{Pl}^2 \, c$$

With this, some of the equations derived above assume the usual form:.

E.g. equation (37) on page 209 turns into the metric-dynamic analogon of the quantum mechanical angular momentum:

$$L_{md} = l\ ƛ_{Pl}{}^2$$

turns into $\quad L_{md} = L^* = l\ \hbar^*$

(Here it is factored in that in the derivation of (37) w stands for w/c.)

Equation (8') $\quad M^* c = \lambda_{Pl}{}^2\ \nu \quad$ (p 176)

turns into $\quad M^* c = h^* \frac{1}{c}\ \nu$

Therefore $\quad M^* c^2 = h^* \nu = E^*$

– and thus also this relationship (which has been derived in Section 9.3 in a metric-dynamic way), appears in the familiar form.

Finally, a note about the gravitational constant G.

It applies $\quad G = G^* \frac{G}{c^2} \quad$ Therefore $\quad G^* = c^2$

This means: the gravitational constant G loses its status as independent natural constant (which is actually self-evident here).

The Newtonian approximation $\quad F = G \frac{M_1 M_2}{r^2}$

changes to $\quad F^* = c^2 \frac{m_1 m_2}{r^2}$

These (arbitrarily chosen) examples support the conjecture that it is indeed possible to remove the mass in kilograms from the physical description system and replace it with the mass in meters. In particular, the examples in which this substitution transforms a purely metrically derived result into a known fundamental equation, provide further evidence that the entire physics can be traced back to a metric basis.

Analogously to gravity, where the mass in kilograms was replaced by the mass in meters, in electromagnetism the electrical charge in coulomb would have to be replaced by the electrical charge in meters. But since there is still no metric theory of electromagnetism, here we have unfortunately reached the end of the road.

However, I am still fascinated by the possibility of a purely metric description system, and it seemed appropriate to me to close the chapter on the metric-dynamic atom structure with this vision.

Note:

Through the metric-dynamic approach to reality, physics is divided into two: *beneath* the previous (known) physics a purely metric structure is placed, which contains *all causal relations* and which therefore, in this sense, represents the *actual reality*. Here, there are only 2 basic units: meter and second.

Since current physics only reflects the realm of experience, it cannot contain any causal relations. There are two ways to connect it with its causal metric basis:

The first option is to add the missing units – such as kilogram – through *definition*, where "defining" here means: "linking with experience" (see e.g. here), as we have done in all cases so far.

In this addendum I wanted to present the second possibility: *none* of the missing basic units are re-introduced, instead the known physical quantities that contain these units are *replaced* by their metric-dynamic analogues – i.e. they are expressed by meters and seconds, as demonstrated in the examples above.

(Then the weight and charge of an object are no longer given in *kilograms* or *coulombs*, but in *meters*, which means: by the amount of the metric compression they cause.)

10. Waves with Light Speed $\longrightarrow$ No Dark Energy

In order to measure, units are needed. Our units of meter and second are defined by atomic processes. "Second" follows from the frequency and "meter" from the wavelength of the light that is emitted during an atomic transition or is in resonance with this transition.

All measured distances – including those from distant objects in the cosmos – are related to the wavelength that we have chosen as basis for defining the unit of length: they are multiples of this wavelength.

Therefore measuring means establishing a relation.

In everyday life we are entitled to treat one of the two partners in the relation – the scale – as *absolute*, i.e. to assume that it is perfectly constant. If we measure different lengths for the same object at two different times, then we assume that the object has changed and not the scale.

In this "everyday" case, however, there is a good reason for this assessment: normally *everything else* remains the same size, so it would be nonsensical to assume that the size of our scale has changed.

But what if *everything* had changed in relation to our scale – let's say: become larger? Then we would naturally assume that our yardstick has shortened – unless there are compelling reasons to rule that out.

Let us now consider the case that we *actually* encounter – the case that *everything* seems to be moving away from us, the further, the faster. Now we should actually assume that our measure – the wavelength – shortens over time, which apparently is – with respect to the observed redshift – completely equivalent to the usual assumption that everything is moving away.

It should also be borne in mind here that what we previously so carelessly called "everything" in the "everyday" case, is now *really* "everything": everything that exists, indeed *the entire universe*, is measured and determined in its variable distance or extent by our scale, which we postulate as absolute.

It can be argued that in this case the absolute-setting of our scale – the wavelength we have chosen – comes under some pressure, if it not even seems absurd: can it actually be justified to assume something that exists as absolute and to conclude from its size that the size of the universe varies? Doesn't size *in any case* have to be a *relative* concept?

Before we delve further into this question, let us clarify whether there are reasons to prefer one of the two alternative hypotheses:

Hypothesis 1: ***The universe is expanding***.

Hypothesis 2: ***Our scale is shrinking***.

As for the historical reason for Hypothesis 1 – the redshift – as mentioned, the two hypotheses are logically equivalent.

We will discuss reasons that speak against Hypothesis 1 immediately afterwards. First we ask ourselves: What actually speaks against Hypothesis 2? As it seems, the following:

It is our decision which wavelength we choose to define the unit of length. Basically, it can be every wavelength that is emitted by atoms or molecules.

This means that not only our scale, but *everything that exists* would have to shrink to the same extent – including ourselves.

In the context of standard physics, this condition seems grotesque. In the context of the metric build-up of the description of nature, however, it becomes (almost) self-evident. As follows:

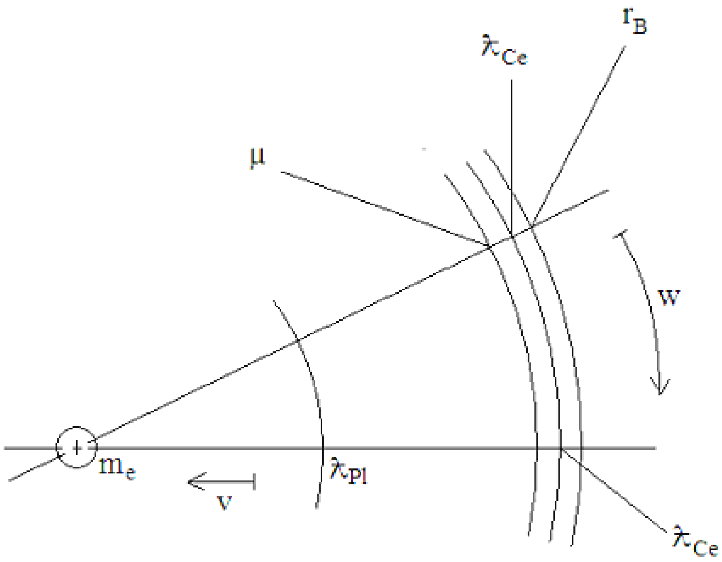
In the previous chapter we assumed a fundamental wavelength that corresponds to the Planck length. We have assigned it to the waves that we already derived in Chapter 3 and viewed as the basis of reality.

In Chapter 6 on relativity we showed that the special relativistic space-time structure can be derived from these waves.

From Chapter 4 on gravity follows that these waves do not travel in the undistorted continuum of SR, but in the metric flows of gravity.

Using the geometric mass m of the electron and the geometric charge μ, under these conditions we built a wave structure in a purely metric manner in Chapter 9 *that corresponds to the quantum mechanical atom.*

Here is again the (logarithmically scaled) overview outline (S8) from page 202 and the associated equations. In the metric-dynamic system, all of these relationships are mediated by waves:



(S8)

$$m_e \, Z'_E = ƛ_{Pl} \quad \text{and} \quad ƛ_{Pl} \, Z'_E = ƛ_{Ce} \quad \text{with} \quad Z'_E = 2.390 \; 10^{22}$$

$$\mu \;\; 1/\alpha = ƛ_{Ce} \quad \text{and} \quad ƛ_{Ce} \;\; 1/\alpha = r_B \quad \text{with} \quad 1/\alpha = 137.036$$

(m_e is the geometric mass of the electron, Z'_E is a multiplicative factor, $ƛ_{Pl}$ is the fundamental wave-length, which we assume as metric basis of all material structures, $ƛ_{Ce}$ is the Compton wave-length; μ is the geometric elementary charge, α is the fine structure constant, r_B is the Bohr radius.)

Let us assume, $ƛ_{Pl}$ is changed by the factor q ($q \in \mathbb{R}$), mass m_e and charge μ remain constant.

So we have: $\lambda\!\!\!^{-}{}_{Pl} \rightarrow \lambda\!\!\!^{-}{}_{Pl}\, q$

Therefore, according to the relationships presented below the above outline, $\lambda\!\!\!^{-}{}_{Ce}$ changes by the factor q^2. It then follows from the second line that r_B changes by the factor q^4.

For the n^{th} radius we have derived (Z atomic number):

$$r_n = n^2 \frac{1}{Z} r_B \qquad (39)$$

Thus for all radii applies:

$$r_n \rightarrow r_n\, q^4$$

However, the radii are derived from the condition that on the associated spherical surface an in-phase oscillation exists. The wavelengths determined in this way then apply to the states with orbital angular momentum 0. States with orbital angular momentum ≠ 0 result from the condition that the circumference is a multiple of the wavelength of the phase wave, which results from the cancellation of the in-phase state as a result of the rotation. The factor q^4 is therefore also retained for the wavelengths of these states.

This means:

If the Planck wavelength changes by a factor q, then all wavelengths of the atoms (related to electron states) change by a factor q^4. [56]

With this, the condition that ***everything*** must shrink by the same factor if hypothesis 2 is true has been reduced to the condition that the Planck wavelength changes.

The decision to be made is therefore simplified to the question:

Is the size of the universe changing, or is it the fundamental wavelength that is changing?

So the argumentative balance has clearly shifted in favor of Hypothesis 2.

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[56] Since the above relationships only apply within atoms and molecules, the wavelengths remain constant after emission.

This shift becomes even more obvious if we now provide further reasons that speak against Hypothesis 1.

If one assumes Hypothesis 1 and interprets the redshift as a consequence of the escape velocity, then based on the measured values it seems unavoidable to assume an *increase* in this velocity.

This is the hour of birth of *dark energy* – from a metric-dynamical perspective one of the darkest chapters in standard physics.[57] Based on Hypothesis 1, as stated, it is unavoidable; but one can't help but wonder what would actually have to happen to call this hypothesis into question. As is well known, it is always possible to immunize a hypothesis against refutation through *ad hoc* assumptions.

Based on Hypothesis 2 the situation is completely different.

There is no expansion at all here – the introduction of dark energy is therefore superfluous. In addition, already the simplest assumption – the assumption of constant reduction of the fundamental wavelength over time – leads to a redshift that would appear as an accelerated expansion assuming Hypothesis 1. (I'll leave it to the reader to check.)

That means:

If we assume Hypothesis 2 – that the wavelength with which we measure is shortening over time – then there is no longer any reason for the assumption of "dark energy". Its introduction becomes superfluous.

An extremely enlightening and gratifying result.

I would like to briefly address once again the problem of setting any standard as absolute.

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[57] In its simplest form, this "dark energy" corresponds to the cosmological constant that Einstein introduced in 1917. It was his only *ad hoc* hypothesis – it was intended to guarantee the possibility of a static universe. Einstein initially tried – inadequately, as he himself later thought – to explain it by a negative pressure. (A. Einstein, *Grundzüge der Relativitätstheorie,* 4. Auflage, Vieweg und Sohn, Braunschweig 1965, p.68 and p.72) Basically, a mathematical freedom is simply used to insert terms of a certain type into Einstein's field equations. Einstein later described this cosmological constant as the "biggest blunder" of his life. Since then, however, it has appeared again and again (on a wide variety of scales), always *ad hoc*, always when contradictions could not be remedied in any other way. As before, it just represents a mathematical freedom; In none of its appearances is it physically motivated – except for one: as vacuum energy, which results from quantum field theory, but here it is at least 10^{100} times too big!

In the metric-dynamic description of nature, it is questionable to a much greater extent than in standard physics to attribute an absolute value to any length. As follows:

That which produces reality is *in itself* indistinguishable. It has no structure and no memory. From this immediately follows that it has no size either. Attributing a size to it is therefore inadmissible.

The *origin of everything* is not an object. The fact that the size of the universe does not exist is therefore not a *logical* but an *ontological* fact.

As a *formal parameter* that belongs to a description system, the size of the universe still exists: I can relate it to the size of every structure in the universe.

However, as an *attribute of the real universe,* "size" does not exist. It therefore cannot change – there is no expansion.

And that's why there is no dark energy.

The relationship between reality and formalism can be represented as follows:

The correct *ontological* statement is: *The universe has no size.*

The corresponding correct *formal* statement is: *The size of the universe is unchanging*.

So if there is a time-varying relation between the size of the universe *itself* and the size of an object *in* the universe, then this change must in any case be attributed to the object.

Remark:

The development of the cosmological standard model involves a tremendous amount of human and material effort. Doesn't this also increase the logical weight of the hypothesis that there is an (accelerated) expansion of the universe?

I think no. There are too many jokers in play. The main ontological joker is *dark matter.* It can be used completely freely: how much is present, when does it decouple from radiation, how big is the initial fluctuation, etc. – everything can be adjusted exactly as the model requires.

The main mathematical joker is *inflation*. *Ad hoc a* new scalar field is introduced – again a version of the cosmological constant! – that is just a *coup de force* to wipe out everything that could endanger the Big Bang assumption.[58] In addition, inflation can be used for a version of the *multiverse*, which in turn gives the opportunity to use chance for everything that cannot be explained.

I certainly understand the excitement about how similar the simulations conducted according to the cosmological standard model are to the real universe. But I believe that this hardly increases the logical weight of Hypothesis 1. With such powerful jokers, it is no longer possible to conclude that the game is played correctly.

Remark:

If one assumes that the fundamental wavelength – and with it all other wavelengths – change over time, one is faced with the question of why this is the case and the related question of what the course of this change is. The choices are: monotonically decreasing, periodic and irregular. If the period is significantly shorter than the age of the universe in standard cosmology, then this should be reflected in the observational data. If monotonically decreasing is true, this would indicate that the structures actually emerged at the time of the Big Bang (which of course does not take place here). The associated cosmology would then probably be related in some respects to the cosmological standard model. In addition, there are two options for monotonically decreasing: until a certain point in time (and then increasing again – perhaps until the structures ultimately dissolve and everything starts anew?), or forever.

In any case, it is clear that the process of wavelength change takes place within the framework of the metric self-organization of the cosmos, and it can be hoped that the answers to the above questions require less absurd hypotheses than the assumption of dark energy.

Finally, it should be noted that by assuming variable wavelengths instead of accelerated expansion, it follows that the universe is a closed metric structure. This suggests that self-organization in the form of standing waves occurs on several scales.[59]

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[58] Also the *ad hoc* hypothesis *inflation* becomes superfluous if the shrinking of the scale is assumed instead of the expansion of the cosmos: without Big Bang, there is no inflation.

[59] For the Radius of the Universe must apply: R(U) = m(U), (m(U) geometric mass of the Universe, $m = M\,G/c^2$), because *any* geometric mass m closes exactly the spatial area with radius m (see 4.4).
Some well-known physicists – among them Paul Dirac – considered the relationship $R(U) = M(U)\,G/c^2$ to be fundamental. The metric-dynamic view explains it in a simple way.

11. Process that Generates Reality → Substantiation of Causality

11.1. The Origin of Causality

Strictly speaking, establishing causality only refers to establishing a connection between cause and effect. But we will extend it to the justification of the existence of natural laws.

First, the cause-and-effect question. The problem can be formulated as follows:

A physical process can be described using the following procedure:

1. Observation, 2. Measurement, 3. Quantification (establishing a mathematical relationship between the measured values of some variables), 4. Creating an equation (generalizing the relationship to all variable values that belong to a given set).

The logical problem occurs in the 4th step: It is associated with the expectation that the equation also applies to cases that have not been observed: cases with different variable values and all future cases in general.

This is the so-called "induction problem": no matter how large the number of observations, no conclusion can be drawn about unobserved cases.

The only remedy would be proof that there is a necessary connection between that, what we assume to be the *cause* of the observed change, and this change itself – i.e. the *effect*.

However, no such evidence is in sight. Without exception, nature presents itself to us as what is the case, i.e. as *individual case*.

But to prove a connection between cause and effect, we would have to show that identical individual cases have identical consequences. For this we would need the existence of the general over these individual cases. However, this general cannot be found in reality – it only exists in the description.

Of course, this is more of a philosophical problem than a physical one. From a philosophical point of view, it is difficult to accept that we must not regard observed regularities as laws, even if they apparently always apply. From a physical point of view, however, it is sufficient to view them as well-founded guesses or working hypotheses.

(If the general does not exist in observable reality, then there are apparently only three possibilities where it could come from:

1. From ourselves

2. From God

3. From a separate area of reality, called Platonic after its inventor

Hypothesis 3 is widespread among natural scientists and even more so among mathematicians, probably primarily because the derivation of mathematical laws is more like a discovery than an invention.

I will not discuss these three possibilities, but instead show that the laws of nature and the *general* arise together with reality itself. In Section 14.2 I will argue that mathematics is also part of the *one* reality and does not have its own Platonic existence. Hypotheses 1, 2 and 3 are then superfluous.)

The induction problem presented above concerns the type of physical hypothesis formation from which physics emerged and which still predominates in it, i.e. the interplay between theory and experiment.[60]

In my book, however, the description of nature is structured completely differently: it is not based on the specific individual case, but rather on the most general premises of being. The individual case serves neither as reason to form hypotheses nor as an example that needs to be generalized.

It is completely excluded from the justification context. It only appears after the hypothesis has been derived, and only for the purpose of connecting this hypothesis with experience and testing it through observation.

This is exactly how we proceeded in all chapters. I now want to repeat this very briefly. First of all, here is the train of thought that forms the starting point of my way to describe reality (see chapters 1 and 2):

The *origin of reality* – that, what is *prior* to everything that exists – we have called *substance*.

Although the substance *itself* is unthinkable, it is still possible to say something *about it*:

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[60] Even in standard physics there are hypotheses that do not come from observation, but follow from *a priori* valid statements, such as conservation laws that are derived from symmetries that can be attributed to the assumed prerequisites of existence: space, space-time, the quantum vacuum, the void, nothingness, etc. In general, however, these hypotheses are not sufficient to derive laws for specific physical processes.

(1) Since we presuppose that substance produces reality, we must attribute *activity* to it.

(2) Without comparison there is no distinction. So distinction presupposes *existence*. Thus, substance – *before* it produces reality – must be *in itself indistinguishable*.

(3) The fact that the substance is *active* means that it abolishes its indistinguishability: Substance is *That Which Changes*. As substance changes, it creates differences and thus rises to existence.

These three statements are necessary and sufficient for deriving an equation that describes the process that produces reality.

Since the substance *in itself* cannot be thought, it must first be determined what it is *for us*:

Substance *in itself* is the logical and ontological prerequisite of *reality*.

What are the logical and ontological presuppositions of the *description* of reality?

Space and time. So *for us*, substance is space and time.

Thus the content of the three statements about the substance simply has to be transferred to space and time. This means:

Space and time must be ***active***, i.e. they must ***change***.

What can change about space and time? Only the measure.

There are two measures for space: length and angle; for time there is only one measure.

From the indistinguishability that is there *prior* to all existence, it follows that there is *no structure* and *no memory*.

Therefore every temporal change can only relate to the previous moment, and every spatial change can only relate to an immediately adjacent location. Changes must therefore be represented as differential quotients.

The basic prerequisite for the further development of the fundamental equation is the fact that without change there would be nothing. Therefore, from every change has to follow another change, so that the chain of changes becomes endless. Since the number of different possible changes is limited, the circle must close, i.e. the first change must also be the result of another change. The shortest possible variant of this procedure then leads directly to the fundamental equation (0).

All assumptions are valid *a priori*, all conclusions are logical. No generalization is necessary at any point in the train of thought. Thus equation (0)

$$\frac{d\sigma}{dr} = \pm \frac{d\zeta}{dct}$$

– where σ is the metric density of length or angle and ζ is the metric density of time – is derived *exclusively* from general, *a priori* valid hypotheses.

It establishes a fundamental causal relationship between temporal and spatial density. Everything that can be derived from this equation and other general metric assumptions *inherits i*ts causality.

If equation (0) actually represents the process of creating reality, then this applies to the entire description of reality, insofar it is derivable at all.

However, there is a complication that we have not discussed yet:

Our derivation of equation (0) ensures that the situation presented is a *valid causal relationship*. At first, however, it seems possible that this relationship applies

1.) only at a single position in space, 2.) only at a single point in time, and 3.) only to a single value of the differential quotients.

But this can be ruled out in the following way:

Equation (0) describes how reality arises from a state *prior* to all existence: In this state, substance is *in itself* indistinguishable – there is no structure, no memory and no size.

These properties must be transferred to what the substance is *for us*, i.e. to space and time.

It follows that in this state there is a) no way to specify a position, b) no way to mark a point in time, and c) no way to define units of length or time.

The claim that equation (0) only applies at a certain position or only at a certain time or only for a certain quantity would therefore be nonsensical.

This means that in this state it is impossible to distinguish whether (0) describes an individual case or a general relation.

With regard to a) and b), this conclusion is self-evident.

For c) it can be demonstrated by the following simple example:

Let P be a point in a plane with coordinates x_0 and y_0. Let $x_0 = y_0$. Then P is a point on the 45° line through the coordinate origin.

But if there is no unit of length, then the position of the point on the line becomes arbitrary, in other words: without specifying a unit, the point and the line are indistinguishable.

This means that here, without defining units, *general and individual are equivalent*.

And this is exactly what applies to equation (0).

From what has been said so far follows:

The two-part statement:

[(0) applies only to **one** point in spacetime with a **certain** value of the two differential quotients]

(and)

[there is no possibility to determine location, time and size]

is equivalent to the statement:

[(0) applies to **all** points in spacetime with **arbitrary** values of the two differential quotients]

Thus the relation expressed by (0) is both individual and general. Here, individual and general cannot be distinguished.

Just as for the justification of *existence*, it is therefore also necessary for the justification of *causality* and the *possibility of natural laws* to go back to the state *prior* to all existence. It is *the only way* to substantiate the general.

Substance creates reality by abolishing its indistinguishability. *For us*, the abolition of indistinguishability applies to space and time.

The differential connection represented by equation (0), which creates the fabric of reality, has no memory and knows no size. By producing reality, it creates a memory and size relations.

In this way, that, what was previously the *individual* (abstract fact) and at the same time the *general* (fundamental law), turns into the individual: into *what is the case* – but only *for us: in itself*, what is the case, the individual, always carries the general in it.

11.2. How Causality is Inherited

Since equation (0) is itself a general statement derived entirely from general statements, the following holds:

If equation (0) is true, it describes and substantiates an actually existing causal relationship between the metric density of space and the metric density of time. Any proposition – whether it is a statement or an equation – that is derived from equation (0) and other general metric propositions *inherits* the causality of (0), and if these "other propositions" are also true, then it itself is likewise true.

However, only statements or equations that deal *exclusively* with metric facts can be derived directly. For statements that contain non-metric facts, an intermediate step is required through which this new fact – or more precisely: the unit that is associated with it – is defined.

Gravitation serves as an example:

Equation (6) is derived directly:

$$\frac{dv}{dt} = -c^2 \frac{m}{r^2} \qquad (6)$$

Here m has the dimension *length*. If m is understood as geometric mass ($m = MG/c^2$), then the result is (M mass in kilograms, G gravitational constant)

$$\frac{dv}{dt} = -\frac{MG}{r^2} \qquad (7)$$

This corresponds to the Newtonian gravitational acceleration caused by a mass M.

The relationship $m = MG/c^2$ represents this intermediate step through which the unit kilogram is defined.[61] This links Newton's gravitational equation, which comes from experience and can therefore only claim the status of an educated guess, to the causal metric structure. In this way, it inherits the causality of equation (0) and thus receives the status of a universally valid law.

[61] "Defined" here has the following meaning: If the geometric mass of an object is known, this object can be weighed. The unit whose multiple is displayed on the scale can then be *called* "kilogram". In this way, the abstract metric basis becomes connected with experience.

Moreover, this argument shows that causality is also inherited from hypotheses that are only approximately valid. Since (6) is directly derived and (6) and (7) are formally identical, (7) must also be universally valid.

Then, however, it still needs to be shown in a metric-dynamic way why equation (7) is only an approximation and in which cases it is applicable. The fact that (6) applies exactly and (7) applies only approximately is due to the different physical interpretation: the acceleration in (6) acts on the metric (the metric flow), while the Newtonian acceleration acts on objects.[62]

I refrain from repeating how the connection between known physics and the metric basis of reality has been established in all previous chapters.

However, one fact seems so important to me that I would like to briefly address it:

So far all that has been said relates to the fact that causality passes from one equation or proposition to another equation or proposition in a mathematical or logical way – i.e. in a *formal* way, through *derivation*.

However, it is not necessary for the transfer to occur in this manner; the connection between causal metric structure and empirical facts can also be established through *explanations*. If these explanations are correct, causality is transmitted through them in the same way as through deductions.

In Chapter 7 on quantum mechanics, this was exactly the case: the quantum mechanical formalism was linked to the causal metric basis, first through examples and then also generally, through explanations.

Finally, it is also possible to transfer causality from generally valid relationships to statements of non-mathematical nature through derivation or explanation, so that they too can claim general validity.

This will be important for the changes in our view of reality that we will perform in the following chapters.

[62] Equation (7) is only an approximation because, from the metric-dynamic point of view, it applies in a coordinate system in which the speed of light is not constant and because the metric changes are not taken into account.

11.3. What Causality Does Not Extend To

Since equation (0) describes the creation of all of reality, it may initially seem as if the causality of (0) is transferred to all of reality, in other words: as if reality were a mathematical system and everything was therefore determined.

However, this seemingly obvious assumption is wrong.

In fact, reality is *not* a mathematical system. What is true is that it *transcends* any such system. If one tries to identify it with a mathematical system, then it constantly creates states that correspond to Gödel statements with regard to this system, i.e. that cannot be derived from the axioms and rules of the system.

But I just want to announce this here; The implementation is reserved for the following chapters.

The next chapter will show what the initial deception just mentioned consists of, and what changes in our view of reality we are led to in order to lift this deception.

Initially – in a first round – the argument is carried out for a specific purpose: to justify *free will*.

For this it is sufficient to show that the physical causality is incomplete and that other types of causality exist.

To understand why *sensation* is a necessary prerequisite of mental activity, however, one must then include the complete conceptual expansion of the scientific view of reality that we established at the beginning of this book.

In the subsequent chapter it will be proven, under the same conditions and with the same means, that robots cannot feel anything and have no consciousness.

So the next two chapters will show *who* or *what* we are or are not.

And it will turn out that the expansion we have undertaken is suitable for viewing ourselves as part of nature in exactly the way in which we intuitively experience and understand ourselves – and by that I mean: equipped with free will, sensation and consciousness.

12. Primordial Scenario ⟶ Substantiation of Free Will and Qualia

12.1. The Substantiation of Free Will

Our argument to justify free will has the following logical structure:

1. First, we will resort to the difference between reality and description, which was presented in Chapter 1. Based on this, it can be shown that the physical causality – in the following referred to as "causality from below" – is *incomplete*.

2. This is a necessary condition for assuming causality in more complex layers of reality governed by nonphysical laws. This type of causality – in the following referred to as "causality from above" – is explained by an example and then generally justified.

3. The explanation applies also to the human neural network. From this follows that the mental layer is the *causal layer* of the network.

4. In contrast to the laws of physics, mental laws are changeable. Since the mental processes are the causal processes, also these changes must be attributed to the mental activity.

5. Therefore, to a voluntary decision the following applies:

a) It is not a *physical* but a *mental* process.

b) The decision-making process can change the laws that applied before it started. However, if only by this process itself is decided what will happen, the decision cannot be determined beforehand.

So it is free.

1. The Difference Between Reality and Description

In our universe, the following seems to apply:

Everything that exists **consists of elementary objects that interact with each other. How these objects behave *is completely regulated by physical laws*. Thus, the entire future development follows from so-called "initial conditions" – the totality of the attributes of all objects at any point in time – and physical laws.**

In this picture that is so convincingly presented to us by science, there seems to be no room for anything other than physics. No matter how complex the aggregates are into which the elementary physical objects are assembled, no matter what fantastic creations evolution produces – *ultimately* everything remains physics. There is just no room for anything else.

This fact can be specified as follows:

In this so-called *reductionist* view of reality just presented, causality always remains "below", i.e. in the *elementary layer* of reality.

All other, more complex layers have lost their independence. Descriptions that refer to these layers – such as neural or psychological descriptions of human actions – are just simplified, approximately valid summaries of processes that are actually of physical nature.

The consequences of these hypotheses are rather strange, if not to say bizarre:

If we assume, for example, that we made an assertion B ***because*** it is logically correct, then that would be a self-deception: It would mean postulating a causality at the level of mental processes, so to speak a causality from "above" – which, however, is inadmissible after what has just been said; B would then be "causally overdetermined". If this "causality from above" could actually claim an independent existence – *in addition* to the "causality from below" – then it would have to be possible to decide *against* the physical causality.

There would be only one possibility that B could actually correspond to logic: that evolution had adapted the physical processes in our brain to the requirements of reality to such an extent that we behave and think logically to a sufficient degree for our survival.

But I emphasize again: the conviction that we made the assertion B *because* it is logical would be a delusion, a ruse of evolution to reinforce our adapted behavior through a pleasant feeling. And, incidentally, we would never be able to determine whether something like "logic" exists at all, since *understanding* something would also be a mental process that does not exist *as such*. Insights would not be insights, thoughts would not be thoughts, mind would have disappeared, *we ourselves* would have evaporated in the fog of self-delusions ...

So it is a completely absurd picture that follows from the reductionist view, and I believe that it is only so widespread because no reductionist has ever fully considered the consequences of his or her convictions. (If there still were one, however, he or she would have long since fallen silent and would therefore be untraceable.)

I want to briefly touch on the two most popular attempts to "defuse" the problem.

The first objection is, that – because of quantum mechanical uncertainty – in nature itself an "objective indeterminacy" exists, so that it cannot be said that "the future follows from initial conditions and laws". However, it can be said that "the future depends *exclusively* on initial conditions and laws" – save that these laws are no longer deterministic. The following conclusions then remain valid.

However, the most common objection to reductionism is, that in most cases a complete reduction has not been achieved and will probably never be possible. I consider this objection inadequate: whether there *is* a reduction cannot be decided by whether *we* are able to carry it out – the picture of reality sketched above, which is the basis of the incredible success of natural science, is not questioned by the restrictions which *our* means and abilities are subject to, and this applies also to the conclusions drawn from this picture.

Therefore, in order to avoid these strange inferences, it is necessary to put the picture itself into question. So we ask: *Is the hypothesis A true?*

A: ***Everything which happens follows from physical laws and initial conditions.***

Let us start with a thought experiment:

We consider the following scenario: a large number of any material objects in empty space that are moving randomly relative to each other, but in such a way that they remain gravitationally bound to one another.

Let us assume that we were able to grasp the initial conditions – the totality of the attributes of all objects of the system – with absolute precision and transfer them to a description. So we ignore that we cannot measure with infinite accuracy, or that we are not even able to write or store the value of a single attribute with infinite accuracy. We also assume that our law of gravitation is correct and that we are able to perform all the necessary calculations.

Now we compare the situation in the *really existing system* with the situation in the *description system*.

Under the above conditions, in the *existing system* exactly what we expect will undoubtedly happen: every object will behave precisely as gravitation dictates. Thus, here, hypothesis A seems to be confirmed.

And in the *description system*? Well, here, at first *nothing at all* happens. Although we have inserted the infinitely precise values of all attributes into our equations, so that they actually represent the objects and their development in time *perfectly,* still the equations do not behave like the objects themselves: While – starting from the point in time that we have chosen to measure their attributes – the *actually existing objects* move on *by themselves* and, in this way, carry out the gravitationally determined dynamics of the system, the *equations* obviously do *not* do that – they simply remain unchanged as we have noted them.

This is actually completely obvious. Nevertheless, I was a little more explicit than necessary because here we have come across an extremely important issue, which, however, so far almost completely escaped both philosophical reflection and scientific research – presumably precisely *because* of its ostensible obviousness. It reads as follows:

<u>Proposition:</u>

There is a fundamental difference between a really existing system and its representation: the really existing system is <u>active</u>, but the representation is <u>not active</u>.

Let us return to our thought experiment. We have stated: In the *existing system*, every object will behave exactly as gravitation dictates. Does this actually confirm hypothesis A?

The answer is: *No, it does not!* Actually, we have *added* something to the really existing system that is not contained in A: *activity*.

The fact that reality is *active* means: at any point at any time exactly what has to happen happens *by itself*. It means that reality does not need a law or an algorithm, because it simply processes all individual cases at the same time.

Obviously, however, *activity* is precisely that which cannot be transferred from the reality to its representation. It can be said that the *type* of activity of the system, its *specific structure*, must be contained in our equations of the gravitational field, but the *activity itself* is missing.

Let us note: Because of its *activity*, reality advances *by itself* from the present to the future. But the description system refuses to do us this favor. In order to obtain information about the future of the system in our description, we therefore need a *mathematical procedure* that substitutes the missing activity.

Do we have such a procedure? First of all, it is clear that for a "large number" of objects that move randomly, our equations cannot be solved. In fact, we have only one way to obtain knowledge about the further development of the system: Since we know the gravitational field, we can calculate for each object where it *would have moved* after a certain time interval *in this field* – and here, the subjunctive is necessary because of course it does *not* move in *this* field: indeed not only the object we are looking at is moving but also all other objects, and this means that also the field itself is constantly changing. But in order to be able to calculate anything at all, for small time intervals we have to assume the field as *static*. We then do the same kind of calculation for all bodies. Then we repeat this procedure for the next time interval etc.

The crucial point is that from start to finish we depend on *approximations*, and that we also do not know to what extent our calculations deviate from reality. At the latest after the next branching point – that is a point in the development of a system at which an arbitrarily small difference in the initial conditions can lead to completely different states of the whole system – our prediction becomes pure luck.

With this we have shown that hypothesis A is false. Since there is no procedure which enables us to conclude the future from the present, A cannot be maintained.

<u>Proposition:</u>

There are systems whose future development does <u>not</u> follow from physical laws and initial conditions.

But isn't reality itself constantly showing us that the future follows from the present? Not at all. What we see is just that the future "follows" the present. It is only this suggestive picture of reality conveyed by physics that leads us to believe that everything "follows from" initial conditions and laws. However, the expression "follows from" is a logical conjunction that can only relate to a description. To apply it to reality means to replace the "follows" that we observe with the "follows from" that we postulate; But we have to *justify* this act of substitution, and so we are forced to replace our "follows from" by a series of logical steps. Thus we inevitably end up with a mathematical procedure, and finally again with the fact that no such procedure exists – even if we imagine we were freed from all restrictions of measuring and calculating.

So the future does not always follow from the present. What does this result mean?

The most important consequence is that a *logical free space* is created: If initial conditions and physical laws were sufficient to derive the future, then there would be no room in the set of conditions for the derivation of the future; But since they are *not* sufficient, there is now room for further elements in this set.

Proposition:

Causality from below is incomplete. There is room for causality from above.

2. Non-Physical Causality

Our next step will be to clarify what kind of "further conditions" could exist on which the future development of systems depends – in addition to initial conditions and physical laws. Is it any other kind of data? Or other kinds of laws? To determine this, we change the scene.

We consider a simple glass vessel. When we hit it, it vibrates and makes a sound. What does this tone depend on? What determines its height and character? The answer is: *the shape of the vessel.* It gives rise to a mathematical law that enables us to predict the vibration pattern of the glass. So here we don't have to go into the physical objects – the glass molecules – nor the physical interaction – the electromagnetism – in order to predict the sound. The only physical information needed is the speed of the sound propagation in the glass.

The law that now allows us to predict the future of the system is therefore *not a physical law.* It belongs to another kind of laws which I shall call ***Laws of Form*** or ***Laws of Structure***.

Let us compare our two scenarios, that of the gravitating bodies and that of the vibrating vessel:

In the gravitation scenario, the initial conditions are given as ***local parameters***, as attributes of the individual bodies. Their values are inserted into the ***physical law*** – the law of gravity. Although everything that happens fully conforms to this law, it is still impossible to predict the further development. The future of the system ***does not follow*** from its present.

In the glass scenario, it is not the attributes of the glass molecules that are inserted into the law, but the dimensions of the glass, i.e. ***global parameters***. The law is not a physical law, but a ***Law of Structure***. The further development can be derived from the global parameters and the law. The future of the system ***does follow*** from its present.

The sound that we hear is largely independent of the way we produce it. However, this does not apply to the first moment: initially, there is a transient process that depends on how we strike the vessel. Only after this process it does always vibrate in the same state. This state to which the glass ultimately adapts – the vibrational pattern into which it develops and which it then maintains – is called ***attractor***.

Above, we asked ourselves what types of data and laws could there be in addition to physical initial conditions and laws. The simple example of the vibrating vessel gave us an answer:

1. new data in the form of *global parameters.*
2. new laws in the form of *Laws of Structure* that are based on the global parameters.

Since these new data and laws can be used to predict the future of the system, they are in fact elements of the "set of conditions for deriving the future" mentioned above.

However, most important for our considerations is undoubtedly the following:

The local parameters – such as the positions and velocities of the glass molecules – initially depend on where, with what and how hard we hit the vessel. So at first they can be quite different. Regardless of this difference, the state of the vessel always evolves towards the same vibrational pattern – the attractor.

In the case of a glass vessel, there is only one possible vibration pattern that always develops, regardless of how the vessel is struck. The future movements of the components of the vessel – the glass molecules – are therefore determined by this pattern.

Causality works from the whole to the individual, from the vessel to its components, and not the other way round.

<u>Proposition:</u>

A form of "causality from above" occurs when in a system *attractors* exist, i.e. states which the system will *inevitably* evolve into, if it is "close enough" to the attractor state.

(A necessary condition that it is actually "causality from above" is that the physical causality in the respective system – the "causality from below" – is *incomplete,* just as we have demonstrated in the gravitation scenario. However, since the glass vessel was only intended to demonstrate what our argument is about, we do not need to worry about whether this condition is met here.)

Now we have made all necessary preparations to move on to our final and decisive scenario:

3. The Human Neural Network

Subject of our investigation is the following question:

What kind of causality does the neural network obey?

In the network, there are three levels of increasing complexity:

1. the physical level
2. the neural level
3. the mental level

In relation to this classification, our question is:

Of which kind of processes does it depend what happens in the net? Of physical, neural or mental processes? Which level is the <u>causal</u> level? – Or, to put it another way: Which level is <u>dominant</u>?

First to the physical level. Let us assume we had complete knowledge of the values of the attributes of all physical objects in the network and could thus set up the system of equations that represents the state of the network and its further development. (Of course this idea is completely absurd, but in the form of a thought experiment it is permissible – *in principle*, this system of equations must exist.)

But now we are again confronted with the problem that already prevented the calculation of the development of the system in the gravitation scenario: An enormous number of processes are running at the same time, and each of them is directly networked with several others. In order to be able to calculate any process, we have to assume at least for a small time interval that its immediate environment is constant – i.e. we have to isolate it for a short time. Then we can do the same for all other processes, and after that we repeat the whole procedure for the next time interval etc.

As with the gravitation scenario, we are therefore dependent on approximations that can deviate considerably from reality already after a short time. It is not possible to predict how the network will develop. The claim "What happens in the network follows from initial conditions and physical laws" is wrong.

And here, too, the following applies again: Reality does what we are not able to do: due to its *activity*, it executes the enormous number of processes at the same time, so that we get the impression that everything "follows from" initial conditions and physical laws.

<u>Proposition:</u>

In the neural network, the physical causality is incomplete. There is room for causality from above.

Let us now consider the *neural level*. It consists of many billions of neurons. Each neuron is directly connected to hundreds or even thousands of other neurons, and *all* neurons are linked to one another via a few intermediate steps.

The neural activity is regulated by a law that follows from the neural input-output mechanism.[63] This law can be understood as the *law of interaction* of the neurons. (It also serves as basis for computer simulations.)

Also at the neural level, it initially seems completely natural to us that what will happen in the network follows from the initial conditions of the neurons and their law of interaction. And again we have to recognize that we succumbed to the same deception, in that we have not differentiated between reality and description or confused them:

[63] The expression "input-output mechanism" means the following: The dendrites of each neuron are stimulated or inhibited by other neurons via synapses. The electrical excitation caused in this way is passed on to the cell body and added up there. When a certain limit is exceeded, it is released to the axon and distributed to its branches, so that ultimately it influences other neurons via synaptic connections.

Since the neural interaction law is a summary of physical circumstances, the argument with which we have just refuted the claim that everything follows from initial conditions and physical laws remains valid. Thus for the neural level the following applies: The high degree of networking of the neurons – the permanent feedback that results from it – precludes the existence of a mathematical method for calculating the further development.

<u>Proposition:</u>

Also the description by neural initial conditions and the neural interaction law leaves room for causality from above.

This brings us at last to the most complex level, the *level of the mind*. We make the following assumptions:

1. Every kind of mental activity (thoughts, chains of associations, sequences of images, etc.) is a sequence of neural activation-patterns.
2. Sequences of neural activation-patterns can be representations of facts.[64]

Let us look at the neural patterns. How do they become representations?

Let us imagine a neural network in which there are no representations yet. An object perceived for the first time will cause a certain pattern in this network, starting from the primary visual cortex. The neural connections that are active are strengthened because of this very activity. The same is the case with each repetition. This gradually creates a stable connection between the object and a specific neural pattern (or rather an ensemble of specific neural patterns).

In addition, the following applies: Although the neural patterns are initially caused by external stimuli, after a sufficient number of repetitions they are also produced by the neural network independently of these stimuli. This means:

Neural patterns that are connected to objects in the manner just described are* attractors *of the network.

Previously we have stated:

[64] Here, "facts" must be understood in the widest-possible sense.

Under the condition that the causality from below is incomplete, from the existence of attractors follows that the respective system – provided it is "close enough" to the attractor state[65] or in this state itself – is governed by causality from above.

However, according to our first premise, a mental process consists not only of neural patterns, but also of the transitions between these patterns. But to this transitions the same applies as to the patterns themselves: First, they are determined by the sequence in which the causative objects appear. If this sequence is repeated, the corresponding neural activity is reinforced, and this has the consequence that the patterns occur again in the same sequence even if they are generated by the network itself. In the same way, also the spatial relationships of the objects are transferred to the patterns.

This means: In the processes that are generated by the network itself, the neural patterns that are in a stable connection with specific objects appear in the same spatial and temporal contexts as the objects themselves.

Therefore, *the patterns can be understood as representations of the objects, and the processes as representations of the facts in which the objects appear.*

So, in human neural networks it is not the physical or neural conditions and laws that determine what happens in the network, but *the structure of the network* – the fact which attractors there are and how their sequence is regulated – on which the processes depend that run in the network.

Causality acts from the whole to the individual, from the network on its components, and not the other way round.

We have thus achieved our first goal:

<u>Proposition:</u>

The neural network is regulated by *causality from above*. The mental level is the dominant level. In it lie the *causes* for the processes running in the network.

[65] Without the concept of phase space, this "close enough" cannot really be defined. In any case, the neural network is always "close enough" to an attractor state.

So the statements we made so far were *actually* conclusions and not just physical processes! Or – to follow up on the formulations used in the criticism of reductionism: Insights are insights, thoughts are thoughts, mind is set in its rights, *we ourselves* are indeed we ourselves …

So far, so good, but that doesn't take us to where we actually want to be. Just because we have moved causality up doesn't mean we are free. We have only replaced physical or neural causality with mental causality. We have thus achieved that our mind is not ruled by physical or neural laws, but *by its own law: the Law of Structure, which the sequence of neural patterns obeys that represent something*.

But don't we ultimately remain trapped in the scheme of initial conditions and laws from which we wanted to escape? Fortunately, that's not the case. To show this, we need to look at the difference between physical and mental laws.

4. The Difference Between Physical and Mental Laws

Human neural networks differ greatly from one another, even if they have not yet been structured by external stimuli. From this follows immediately that the patterns that represent something are also different in all people, even if the represented facts are identical.

As stated above, initially the order of the patterns is determined by the order in which the objects or circumstances that cause the patterns occur. But as soon as the network is able to produce these patterns itself, the transition rules of the patterns – what we have called the *mental law* – increasingly depend on their use in internal processes. This dependence on external and internal conditions means that the transition rules differ from person to person.

So we have already determined the first difference:

While physical laws are ***generally valid****, mental laws are* ***individually valid*** *– they only apply to one singular person.*

Connections between neurons are strengthened when they are active,[66] and weakened when they are inactive. This means that every mental activity alters the structure of the network. But if the

[66] This finding goes back to Donald Hebb, who stated in *The Organization of Behavior* in 1949: "When an axon of cell A is near enough to excite B and repeatedly or persistently takes part in firing it, some growth process or metabolic change takes place in one or both cells such that A's efficiency, as one of the cells firing B, is increased."

structure can change, then obviously also the rules that determine the sequences of the neural patterns can change.

So this is the second difference:

*Physical laws are **immutable**, mental laws are **modifiable**.*

<u>Proposition:</u>

Physical laws are universal and immutable. Mental laws are individual and modifiable.

5. The Substantiation of Freedom

The most obvious implication of the strengthening of active neural connections is that what we always think, feel and do is self-reinforcing. Basically, however, it goes without saying that also the opposite can occur:

We have shown that causality is to be found at the mental level. *Will* and *intention* must be understood as elements of mental causality. Now let us imagine concretely we were faced with an important decision. When we enter the decision-making process, we are initially guided onto certain, well-known paths by the regularities that are valid up to that point – i.e. by our own mental law.

But at any time we are able to leave these paths, for example by simply considering the opposite of what we have assumed up to then, or by taking a path we never tried before; We are able to do so precisely for the reason that the causes for what happens in the network – and thus also for the modifications of the network structure – lie at the mental level.

In other words:

The law that determines the sequence of neural patterns in our network that represent something, i.e. our own mental law, can be altered *by ourselves*: we ourselves can change the laws of our thinking and acting through our thinking and acting, and we can do it *deliberately.*

This means at the same time:

Although mental processes are governed by their own rules, it is not possible to derive a volitional decision from them: the decision cannot be contained in these rules because they can be changed by the mental process that precedes the decision. While this process is taking place, the laws that it obeys can change – or, more precisely, *it itself* can change the laws that applied before it started.

Proposition:

Volitional decisions are causes of actions. Since only by the decision-making process itself is decided what will happen, the decision is not determined beforehand.

So the decision is free.

To the question of why a (sane) person has decided so and not otherwise, there is then only one permissible answer:

Because he/she wanted it that way.

Note:

Of course this does not mean that volitional decisions cannot be analyzed with respect to their neural, chemical, physical, genetic, social etc. causes. It means, however, that these analyses necessarily remain incomplete and never lead to a secure result, because mental phenomena cannot be reduced to other layers of reality. The will remains the final authority.

Postscript

In reviewing the text, it seemed to me that I followed my goal of presenting the topic as briefly and simply as possible perhaps a little too radically. Therefore I will try to explain the most important points of my argument one more time:

Let us assume we have to describe a system that consists of a large number of physical processes that are linked to one another. Then the equations of the processes are also networked with one another.

For an exact description, we would therefore need the values of all parameters of any process at every moment in order to insert them into the equations of all other processes – in other words: it is (except in very simple cases) *impossible* – for reasons of principle, and not just because of the limitations of measurement and calculation – to make accurate predictions about the system that consists of all these processes by using *physical means*.

And with that we would have actually reached the end of our possibilities – *unless* the processes could be understood as elements of a "structure of a higher order", in which further laws apply. These "higher order laws", however, are then *no physical laws*, and with that we have left the field of physics.

If these new laws make it possible to predict the development of the overall system, then the following applies:

1. The development of the overall system ***does <u>not</u> follow from physical laws***.
2. The development of the overall system ***<u>does</u> follow from higher-order laws***.

Of course, everything continues to happen ***in accordance*** with the laws of physics – but these laws now take place within a ***higher-level structure***. (Think of the vibrating glass vessel.)

So causality is no longer *below,* which means: in the elementary, physical realm. It has migrated *upwards*, into a realm of higher order, in which ***new, non-physical laws*** apply.

Exactly these conditions can be found in the neural network, and in fact several times:

In a neuron, numerous physical processes take place at the same time. Although the physical approach allows us to understand what is going on in the neuron, still the coupling of the processes prevents any exact calculation of the further development. However, due to the shape and structure of the neuron, these processes are embedded in a system of higher-order, so that they obey a "structural law" – the one that we previously called "neural input-output law".

Now, however, it again applies that this law does not allow us to make any precise predictions about the future development of the many neurons that are coupled to one another. But the neurons themselves are again elements of a higher-order system: the neural network with its imprinted patterns (attractors). So the neurons are also subject to a new law: a structural law of again higher order: the law of the sequence of neural patterns, and that means: ***the law of the mind***. Thus mind is the causal layer; It determines the processes that take place in the network – including those that change this law itself.

Finally, I shall repeat the difference between description and reality:

In order to get from the present to the future in the ***description*** of a system, we need some kind of procedures. These can be mathematical procedures, algorithms or equations, but also methods to combine facts in such a way that conclusions can be drawn. In some cases we are able to do this so well that we can state: *B follows from A*.

In the ***reality***, none of this is necessary. If what has to happen happens in every place at every time, then the future will arise *by itself*, and then all complex objects and structures, including their laws, will develop *by themselves*.

But from the fact that in the reality the execution of elementary processes is sufficient for the creation of the future, it cannot be concluded that the future ***follows from*** elementary processes, because that would presuppose that that, what in the reality happens ***by itself***, can be expressed by ***a series of logical steps***, and that is impossible.

<u>Note:</u>

In this justification of free will, it is not necessary that a "bifurcation" exists in the development of the world. The key point here is that *the future is not contained in the present* – that is, it does not *follow* from the present but merely *arises* from it, and that the reasons for what will then actually happen are of a mental nature.

<u>Note:</u>

In order to recognize objects, artificial neural networks must be trained on large data sets. In numerous repetitions the connection strengths of their neurons are varied until a sufficiently high recognition rate is achieved.

In contrast, we started from the following hypothesis: A perceived object, which causes a neural activation pattern, is represented *by this pattern itself*. Therefore, here the relationship between object and representation is not established by varying the connection strengths of the neurons, rather it exists already from the beginning and is only stabilized and specified by *strengthening* the active connections, whereby the neural pattern becomes an *attractor*.

This hypothesis is confirmed most clearly by the so-called "imprinting". (As e.g. in the case of the gray geese of Konrad Lorenz). There are neither "large data sets" nor "numerous repetitions" – the process occurs almost instantaneously.

Furthermore, thereafter *immediate recognition* occurs, despite the inevitable variability of the sensory impression to be recognized. Thanks to the attractor concept, this – otherwise hardly explainable – performance becomes self-evident: as long as the sensory input is within the catchment area of the attractor, it obviously applies: *perceiving = recognizing*, since the newly activated attractor already represents the object, so that further calculations are unnecessary.

12.2. The Justification of the Occurrence of Qualia

1. Preface

Now we have finally arrived at the question that contains the real mystery of the mind: the question of the reason for the transformation of a network of information into a world of sensations.

How does *information* become a *quale*?

How does the *machine* transform into a *sentient being*?

What is the difference between the two?

For everything that has been said so far about mind, it was sufficient to regard mental activity as information processing. The autonomy and dominance of the mind as well as the existence of free will could be substantiated in this way.

But now, when we ask how a sequence of neural patterns can become a stream of experiences, an answer based only on this assumption can no longer suffice: As long as one acts on the assumption that mental processes are *nothing but* information processing, one remains captured in the area of information processing.

This doesn't change if one networks representations, or form representations of representations – i.e. higher levels of information processing – or lets information act back on itself: no matter what function is applied to information – the result will always be just information and nothing else.

In this view, no metamorphosis can occur. The information "red" does not turn into the sensation *red*, the information "pressure" does not turn into the sensation *pain*.

Therefore applies:

The assumption that mind is information processing is necessary and sufficient for the derivation of the freedom of will.

But for the substantiation of qualia it is only necessary and not sufficient.

In other words:

The assumption that mind is nothing more than information processing is wrong.

Obviously, sensation – such as *redness* or *pain* – cannot be defined. What is meant by it can only be understood by those who know it from their own experience.

Therefore our first question will be:

Why are sensations not contained in any description?

Sensation is a phenomenon that appears to occur at some stage in the evolutionary development of living beings. The physiological prerequisites that must be fulfilled for its appearance are only necessary, but by no means sufficient conditions.

In short: *We don't know why they occur.*

Therefore our second question is:

Why are there sensations? Can sufficient conditions be determined for their appearance?

As we will now show, both questions can be fully answered based on our assumptions and some of our conclusions.

2. Why Sensations are not Contained in any Description

Starting point for the following argument is the fact on which this book is based: the difference between reality and description, which also played an important role in the section on free will. We determined this difference as follows:

*Really existing objects are **active**, objects in a description are **not active**.*

It follows that actually existing objects must have something about them that objects in a description lack. We called this part of their existence ***substance***.

Substance is therefore that from which the activity of objects originates, that which makes them ***active***.

Although one can recognize that substance is an indispensable element in the description of existing objects, it itself cannot be thought as *what* it is.

The part of the existence of objects that is accessible to our thinking – i.e. about how the objects present themselves and how they act – we called ***accidents***.

In every object, substance and accidents form an ***inseparable unity****:* the earth only exists *with* gravity.

In the section on free will, it was shown that in the human neural network causality does not remain "below" – in the physical area, but shifts "above" – into the realm of mental activity.

The dynamics of the neural network is therefore not determined by objects of the physical level and their accidents: atoms, molecules, and physical interactions, but by objects of the mental level and their accidents: mental states that represent or mean something and information processing.

This means:

The objects that are now subject of our analysis are no longer objects of the physical layer of reality, but rather objects of the mental layer.

We must therefore apply the above statements to *these* objects, in other words: we must conceive mental states as *inseparable units of substance and accidents.*

What is the *substance* of a mental state, what is its *accident*?

Mental states consist of two completely different elements: *information processing* and *sensation*. Information processing is the element of mental states that is accessible to our thinking, sensation is the element that cannot be thought, i.e. cannot be described and defined but can only be felt and experienced, and, in addition, sensation is exactly that, what makes mental states *active*: information without sensation is indifferent and therefore *passive*.

Thus we can state:

Sensation is the substance of the mental state, information processing is its accident. A mental state is an inseparable unity of sensation and information processing.

So the answer to our question: "Why are sensations not definable and describable?" is as follows:

Sensation is the substance of the mental state. As such it cannot be thought or defined. It cannot be included in any description.[67]

The fact that in the discussion about qualia the idea that the information processing, which occurs in the human neural network, could also take place *without* associated sensations turns out to be the result of a deficiency: the lack of the *concept of the mental state*.

If this concept is available, then the *inseparability of sensation and information processing* in the realm of the mind is just as self-evident as the *inseparability of mass and gravity* in the realm of matter.

In both cases it is about the *inseparable, metaphysical unity of substance and accident*.

Annotation:

In the following, I will use the term "quale" to refer to the entire mental state, not only to the feeling associated with it.

Instead of "information" or "information processing", I will sometimes use the term "meaning". Since we are in the realm of the mind, this seems more appropriate to me:

Information is a term that can be used at all evolutionary levels, whereas *meaning* is i*nformation for a subject* and therefore particularly suitable for the realm of the mind.

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[67] If anyone is as surprised as I was when I realized that sensation is the substance of the mental state, then this is probably due to the same mistake that I made: I simply did not understand the term "substance" abstractly enough, which partly is related to the historical connotation of this term.

3. The Transformation of Being from the Material Thing to the Quale

Now to the second question: *Why are there sensations? How is it possible for a material thing – a neural pattern – to transform into a quale?*

First, a few comments on the requirements for our argument and on the argument itself.

In the description of mental activity, we start from the same premises as in the section on free will.

Here is a short reminder:

Mental states are neural patterns that represent or mean something. Since the neural network can create these states without external causes, they must be viewed as *attractors* of the dynamics of the network. Every mental process is a sequence of such patterns.

Mental states are interconnected. Their sequence is determined by a law that is initially imposed on the neural network by external causes. However, as soon as the network is able to produce these patterns out of itself, the transition rules of the patterns as well as their meaning increasingly depend on their use in internal processes.

In the following I will refer to the entirety of processes of this kind as "mind", and to the remaining part of reality as "matter".

In Chapter 2 we defined *space and time* as the substance of everything that exists, and their mutually dependent changes as the associated accident.[68]

But now, we have recognized *sensation* as the substance of the mental area of reality.

What we encounter as substance of the mind appears to be completely different from the substance of matter.

In order to grasp this difference conceptually, I will call the substance of objects that belong to the realm of matter ***first substance***, and the totality of physical accidents ***first accident***.

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[68] For the following argument, however, it is not necessary to know what the substance of material objects is; it is enough to see that substance – as has just been shown – is a necessary part of all existing objects: the part that is inconceivable and indescribable.

However, it should be remembered that the concept of space-time as *substance* is **not** identical with the physical concept space-time: the substance *space-time* is conceived as *that which produces reality*, and as that which makes material things *active*.

The substance of objects that belong to the realm of the mind I will call ***second substance***, and their accident *meaning* ***second accident***.

However, that does *not* mean that there are two substances – rather, the second substance is thought of as emerging from the first substance, and the question we ask ourselves is therefore:

Why does the first substance in the case of qualia transform into the second substance sensation?

We proceed from two facts:

(1) The transformation of being from the material object to the quale occurs through the unfolding of nature into layers of increasing complexity.

(2) The part of this rise that is conceptually accessible to us is the part that occurs on the side of the accidents. So this is where the argument has to take place.

Let us direct our attention to the scenario where we expect the answer: to the evolutionary development of being.

We manage, with some success, to describe and understand the phenomena we find in the material world.[69] Where our knowledge is incomplete, as in the case of the origin of life, this gap can at least be filled by scientific hypotheses. Problems that we meet in the description of nature usually appear as *technical* difficulties, and we never encounter a phenomenon that seems to escape our understanding *on principle* – but that holds true only up to the point where the unfolding nature generates neural networks of high complexity, whose states are qualia.

This leaves us with the question:

Why does the essence of being only change with the development of neural networks of high complexity that produce mind, while until then it seems to be uniform throughout – at least to such an extent that only at this point we feel compelled to introduce a second substance?

Why is that? To understand this, let us consider the relationship between accidents of objects in different evolutionary layers of increasing complexity.

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[69] With the exception of the quantum mechanical measurement paradox, which we have explained elsewhere.

Let us start with the relationship between the physical and chemical level.

As an example of a chemical accident, we choose any kind of chemical bond. What can we do to describe it? We can make measurements, and we can set up the specific Schrödinger equation that is appropriate for our system. In most cases this equation cannot be solved analytically, but through appropriate approximation methods and numerical calculations we can achieve our goal.

The Schrödinger equation is a physical equation. This means:

The accident *chemical bond* can be understood as a function of physical accidents. In this sense, the chemical property *bond* can be *reduced* to the physical level.[70]

As next example, we consider the accidents of the neural level. They obey a law that we called "neural input-output law" in the section on free will.

Here, again the same applies: although due to the numerous physical and chemical processes occurring in parallel we are unable to precisely predict the future state of a neuron, we can still describe and understand the entire procedure that takes place in the neuron as function of physical and chemical conditions and processes.

Thus the neural input-output law can also be reduced to accidents of the levels from which the neural layer of reality is built.

As final example, we choose processes which take place in neural networks that do not produce mind and which, due to their simplicity and genetic pre-structuring, are not suitable for developing, altering and networking attractors.

In such systems, the existing neural processes are not changed through networking with other such processes and the resulting feedback, but always remain in (almost) identical form. They can therefore be viewed as functions of the given architecture of the neural network.

The behavior of animals that have neural networks of this type can then also be described as function of this architecture and external conditions.

Therefore also to this last example applies:

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70 Note that this is a much weaker form of "reducibility" than the calculability of the (future) *state* of the system from physical laws and initial conditions.

The analysis of the accidents shows that they can be understood as functions of the underlying, simpler layers of being.

We have thus reached the following insight:

In all evolutionary transitions to new, more complex layers of being – up to and including neural networks that are not capable of producing mind – the accidents, which occur in the respective new layer, can be described as functions of accidents of simpler layers of being.

The last example has already brought us close to the realm of the mind. So let us now take the last step. Let us pose the question:

Can meaning, the accident of mental states, be understood as function of simpler (atomic, molecular, biochemical, neural) layers of being?

The answer comes from the following consideration:

The postulate that representational states are networked with one another is tantamount to the occurrence of feedback loops: state A influences state B, state B influences state C, which in turn affects state A, etc. On the one hand, such feedback loops reinforce existing patterns, but on the other hand, they can also enable connections between patterns that were not connected before.

With this, the information content of the neural patterns changes: it is increasingly determined by the internal relationships between the neural patterns, while the original functional dependency fades into the background: the representational states develop into intrinsic meanings.

This even applies to perceptions: even if they remain content-bound as representations of real objects – in the primary visual cortex, the neural image of an object, which is observed twice under identical conditions, will in both cases be almost identical – they are, as *mental states*, by no means limited to this representational function. Perception includes any kind of information processing that occurs in the respective cortical area in addition to the processing of the purely sensory information, and a halo of accompanying associations is also part of perceptions.

In the case of mental states, which are not directly linked to outer objects, there is no principle limitation at all for the changes which they are subjected to in the course of their further inner processing within feedback loops. In trains of thought, surprises occur: new conclusions result, new concept formations are required, fallacies must be corrected. In the area of fantasy, the change of existing and the creation of new intrinsic meanings is even the characteristic feature, and the relation to outer objects fades away or tears off completely.

From this follows the ***differentiation criterion*** we are looking for, through which the transition from systems *without* mind to systems *with* mind differs from all other transitions to the respective next higher level:

Meaning, the accident of mental states, can not be understood as function of accidents of simpler layers of being.

A mental state gains its meaning through its position in the network of mental states, i.e. in the network of meanings. Although perceptions and judgments remain bound to the real world, it is – due to the permanent change through feedback loops – impossible to assume any kind of functional dependence of the meaning of mental states.

Does this criterion also provide an explanation as to why the substance of being changes at the transition from matter to mind?

Yes. As follows:

Substance and accident always form an *inseparable unity.*

The *first accident* is *inseparably bound* to the *first substance*.

What can be said about complex accidents and the substance associated with them?

If complex accidents can be reduced, step by step, to simpler accidents, then follows that, ultimately, they can be reduced to the first and simplest accident.

For us, however, *reducibility* means *ontological identity*: If B can be reduced to A, then B ***is*** ultimately A. Thus, if a complex accident can be reduced to the first accident, then it ***is*** ultimately the *first accident,* and then it is inseparably bound to the *first substance*.

This means:

As long as the accidents are reducible, the associated substance remains the same – it is still *first substance*.

But if the chain of reducibility to the first accident is interrupted by the appearance of a new, *irreducible* accident, then this new accident differs from the first accident and from all other accidents that can be derived from it.

However, due to the *inseparability* of first substance and first accident, the following applies:

If the substance of an object is the *first substance*, then the associated accident must be the *first accident*.

And from this follows:

If an accident appears that is different from the first accident, then the associated substance must also be different from the first substance.

<u>Proposition</u>

As long as accidents of higher complexity can be described as functions of accidents of lesser complexity, the substance remains the same.

If this functional dependence disappears, then the substance changes. *For us* it appears then as a new, second substance.

4. Explanations, Additions [71]

1. Though the reason for the transformation of being cannot be proven in a simple way, it can nevertheless be understood intuitively:

If the functional dependencies of neural states on their material preconditions fade and ultimately disappear completely when they are transformed into mental states, then this means that a region of the universe is causally decoupled from the rest of the universe.

Thus a new, self-dependent universe emerges, a *universe of qualia*.

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[71] Since I consider it important to solve problems with a minimum of assumptions, in the argument above I have avoided as much as possible to use elements from the physical part of my description of nature. However, in the following remarks I will drop this restriction, since only the physical-philosophical overall picture allows complete insight. So I will speak of *space-time* as the first substance, and of *mutually dependent metric changes of space and time* as the first accident, and I will assume that they produce the whole of reality.

Meanings are the accidents of the entities of this universe. They must be associated with a substance, and their causal separation from the rest of the universe and its substance *spacetime* suggests that a new substance belongs to these new accidents.

Substance is that which provides being with the metaphysical quality *activity*.

One may now ask: What is it that gives *activity* to the entities of the universe of meanings? What is the dynamic in this universe based on?

The answer is *sensation*. *Sensation* is what drives the qualia. Therefore, sensation is the substance of mental states.

Meaning, on the other hand – that which is the object of descriptions, the definable content of mental states – is *passive*. Meaning is information, and information processing alone – like anything that is merely an element of a description or a representation – never happens by itself. It is dependent on supplied activity.

But it need not be specifically emphasized that this universe of qualia is an *inner* universe, a universe *in the head.* The functional decoupling, which manifests itself in the free flight of thoughts and ideas, does not mean, of course, that the mind, as esoterics and members of various religions believe, can *in fact* liberate itself from its spatial and temporal boundedness. It is brought forth by the neural network, and thus it remains bound to material conditions and captured in space and time.

It is important to always remember that also the first substance *space-time* of the physical being cannot be thought – even if it becomes available to our thinking through the concept of metric changes – and that it is impossible already for this reason alone, to understand its transformation into the second substance *sensation* of the mental being.

However, as has just been shown, it can be proven that this transformation *must* take place.

2. At the beginning of this book, *substance* has been determined as that which is *indistinguishable in itself* and must therefore be *the same for all objects*.

But now we have proven its *transformation*.

So we have once again come across the (ostensible) contradiction that was mentioned at the end of the First Chapter. I repeat the explanation:

If we conceive substance as that which produces reality, then we are considering its *being-in-itself*. It is the substance *in itself*, which *before* (in an ontological sense) all existence, as *neither-existent-nor-non-existent,* is indistinguishable and which rises to reality as *that-which-changes*.

But *in itself,* it always remains substance – it "is" the reality. The unfolding reality is nothing other than the substance in its constant change. Reality *is* substance.

For us, however, being necessarily is divided into substance and accidents.

Since what happens is only accessible to us through accidents, any *change* is – *for us* – transferred to the realm of the accidents. As a result, when we look at being, *for us* the indistinguishability of the substance remains, but its *change* is lost.

So it is the (inevitable) mistake that we had to make already *in the first step* of building the description of nature that drove us into this contradiction:

It occurred when we determined (at the beginning of the Second Chapter) what the substance is *for us*, and when we transformed – no: *distorted* – the *inseparable metaphysical unity* of substance and accident into the relationship between subject and predicate, by conceiving space and time not as *That-What-Changes* but as *something which changes*.

In doing so, we have excluded the substance – whose essence *is* change – from change, and only then, when its change became too glaring – despite our *a priori* given blindness – to remain hidden from us any longer, did we discover with shock that the essence of being has obviously been transformed through the evolutionary rise to systems that produce mind.

At least we were able to understand our mistake and recognize this transformation as necessary.

However, without knowledge of the difference between reality and description and the consequences just described, one is completely helpless in the face of this transformation.

I believe that the discussion – past and present – about qualia reflects this helplessness. How else could one understand the attempt to *eliminate* – or rather, *deny* – qualia, or the attempt of panpsychism to substantiate their appearance by assuming that sensation has always been there because it is a fundamental element of existence, whereby, however, one ends up with the "sensitive elementary particle" and thus runs into serious justification problems.

3. For us, reality is divided into *substance and accident.*

Reality is given to us in the form of the *subject-predicate structure*, in which the subject without a predicate is passive and is therefore only activated through a predicate – *or not:* the connection between subject and predicate is not suitable to express the *inseparable unity* of substance and accident.

It is this *a priori* structure of our language and our thinking that prevents the insight that *everything that exists is active* – even without an activating predicate – and that really existing objects therefore differ in a fundamental way from objects in a representation.

The existence of a material object seems so self-evident to us that a mere reference to it seems to be sufficient to answer the question of *what* it actually is.

Only when one pursues this question down to the elementary objects does this self-evidence evaporate and it becomes clear that the question is unanswerable.

It was precisely this experience that plunged 20th century physics into a crisis and ultimately led to complete abandonment of explanations and retreat into formalism.

But as we have already shown in the physical part of our explanations and now also in the clarification of fundamental philosophical questions, only the analysis of this fact and its integration into the description of nature makes it possible to understand reality and to conceive it as a unity in all its manifestations.

5. Criterion for the Occurrence of Sensations

The considerations of the previous section result in a criterion for the occurrence of qualia.

The existence of a quale implies that its meaning cannot be read from its material structure. This condition is satisfied if and only if neural states that represent or mean something are networked with each other.

Then feedback loops occur in which the information encoded in the neural states is determined to an increasing extent by the mutual relationships of the neural states, while the original dependence from outer conditions diminishes. That, which initially has been *representation,* turns into *intrinsic meaning.*

There is no way to determine what a neural pattern means. This is even true for perceptions: here, it can at most be determined what they *represent*, but not what they *mean*. Contrary to the high hopes of neuroscience, it will never be possible to eavesdrop on someone's mind – unless he/she voluntarily tells what he/she thinks and thus allows the identification of the individual neural encoding of these thoughts.

But, with certainty, even that will be possible only for simple, standardized mental processes.

As already mentioned several times, the just described process of the emergence of intrinsic meaning – and thus also the formation of qualia – can take place only if there is a neural structure that is not functionally predefined.[72]

In humans, this structure is the cerebrum. Its functional independence becomes apparent through its plasticity: if areas fail which, over the course of the individual development, have taken certain tasks, then these tasks can be adopted by other regions.

But also other brain structures can meet the criterion of functional independence. The brain of octopods is structured very differently from our brain, but most likely it contains neural areas of this kind.

On the other hand, the neural structures of the diencephalon – if they are not already hypertrophied – are not suited to network representations in such a way that they can detach themselves from their original function and develop into intrinsic meanings. Regardless of whether this function is part of a genetic program or imprinted by external conditions – the behavior remains schematical and always closely related to the triggering stimulus.

Representations that are integrated into such functional sequences can change only within narrow limits.

Therefore, in brains which – in addition to the evolutionarily even more ancient neural fields – contain only structures similar to those of our diencephalon, most likely the emergence of qualia is not possible.

Thus the necessary condition for the occurrence of qualia is:

Qualia occur in a neural network only if the network contains functionally unbound structures, which permit the networking of neural representation states.

However this is only a necessary condition. Can also a criterion, i.e. a necessary and sufficient condition, be formulated?

I think yes. It reads:

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[72] Such structures appear when a mutation causes the enlargement of an already existing neural structure, e.g. of an area of the diencephalon.

Any animal that has a neural network which contains functionally unbound structures, experiences qualia.[73]

The claim that an animal with such a neural network experiences feelings is based on the following argument:

In an animal, it can be presupposed that its species has already proven its viability, and this is a very strong condition. It includes a lot of technical requirements, of which we know only a few *exactly* and most *not at all*.

There must have been viable progenitors of this species, in the brain of which the neural structure similar to the cerebrum has not yet been present at all or only to a very small extent. Presumably, the organism we are looking at would thus be viable also without the "free" neural structure, and the neural network would contain all functions, which are necessary for the appropriate regulation of its behavior.

But if now this new, initially function-free structure is added, then *inevitably* meta-representations and networked representations will arise, because the information about the environment and the body *must* in some way arrive in the new structure and there be processed further – but again only if the neural extension is a continuation of a neural tissue, which has already proven its ability to function correctly, and not just a bunch of neurons.

This condition, in which again many technical prerequisites are summarized, is certainly met in an animal.

With this, however, it is already proven that this animal has feelings.

6. A Simple Additional Argument

The existence of feelings presupposes that there is *somebody who* feels.

Consider the sensation *pain*: the sensory information can only turn into the sensation *pain* if there is a *subject* who takes note of the sensory information.

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[73] It is important to note that this statement only applies to an animal and not to a robot. Why this is the case will be shown in the next chapter

It is not necessary to determine more precisely what is meant by the terms "somebody" or "subject". It suffices to realize that in a neural network, in which only automated processes that are either genetically programmed or imprinted by environmental conditions, there is no room for this postulated subject.

The assumption of a subject presupposes that stimulus and behavior are not in any case in a fixed connection with each other, like e.g. in the case of a reflex or of an imprinted program. There must also be cases, where the sensory information does not lead directly to the stereotype behavior but *further processing* is applied. Therefore, the neural network must be capable of *meta-representations.*

But obviously, a single meta-representation alone does not suffice to substantiate the assumption of a *subject.* For that, it is required that the meta-representations are stored as memories and networked with each other.

Only then is it justified to assume that there exists *somebody* who feels.

So this simple argument leads again to the necessary condition, which has just been derived: For the appearance of feelings, the existence of a functionally unbound neural structure is required, which enables the networking of the neural representation states.

It must be noted, however, that this is a *structural* argument, and therefore it is, like all structural arguments, inappropriate to substantiate the *metaphysical fact* of the transformation of neural states into qualia. It can only serve for the determination of *necessary* conditions.

7. Who or What has Sensations?

The above formulated criterion for the occurrence of sensations permits drawing a boundary between *machine* and *sentient being.*

The actual classification, however, requires precise knowledge of the structures of the respective neural network and their performance. The intelligence of birds has been underestimated for a long time, because it is not located in the same neural area as in the case of mammals. By now, however, it is well known that some birds are highly intelligent. Birds undoubtedly have sensations.

What about fish? The discovery of structures similar to our diencephalon does *not* represent an indication of feelings. But the question arises whether the complex behavior and learning ability of some fish species suggest the existence of neural structures that meet the criterion of *functional independence*. Perhaps there are fish species in which this is the case.

Some questions, however, can be decided unequivocally using the criterion:

Do bees perceive colors? No. Although different colors are differently represented in their neural networks, the representation remains pure information. A transformation into sensation does not take place.

Do Crustaceans feel pain? No. They are not sentient.

On this side of the border that is drawn by the criterion, there are no sensations. But what is on the other side? What if the initial function-free cerebral-like structure is *very small*?

Are then feelings somehow "paler"? Is *red* less reddish? Is *pain* less painful?

On the one hand, it must be remembered that the indescribability of feelings is transferred to their gradations. It is not possible to describe gradations of something that is not describable.

On the other hand, with feelings we have this special relationship that, though we cannot capture them through descriptions, we still know exactly what they are because they are *directly – as they themselves* – given to us.

Therefore I think that the idea of "paler" or "weaker" emotions and a "dull" or "vague" consciousness is a suitable approximation to the nature of those qualia, which animals experience, in which the functionally unbound neural structures required for the emergence of qualia are less pronounced.

I even suspect that there is only *one possible set of qualia*, so that all beings who experience qualia have essentially *the same qualia*, although of course they can differ massively in their strength and subtlety. In other words, I actually believe that we can feel and imagine "what it's like to be a bat".

An important aspect of the conclusions of the previous section is that – also in neural networks which are capable of forming qualia – qualia are not present from the beginning. The transformation of matter into mind, of representations to intrinsic meanings, of a neural pattern into a quale is a development process.

Postscript

And again I feel exactly the same as in the previous section about free will and as always after completing a topic: I regret that I was not able to present it more simply. But when I try, it just becomes more of the same.

Therefore, this time I will proceed differently: I will force myself to not analyze the qualia problem as precisely and completely as possible, but rather chat about it.

It's also easier for me to say in a conversational tone:

Let's just leave all the craziness aside,

- such as the claim that sensations do not actually exist, and let us sincerely hope that it is not the weakness of their sensations that obscures the absurdity of this hypothesis from the eliminativists,
- or like the assumption that sensation is a basic element of reality, and let's hope that the panpsychists can at least curb their need to hug stones in public,
- or like the assumption that sensations will develop on their own when the computer simulations exceed a certain level of complexity, and let us wish that the designers of artificial intelligence themselves do not just simulate their feelings and that they do not fall for simulated feelings

– and let’s instead ask ourselves seriously:

Why are there sensations? Why do our minds contain elements like "color" or "joy" that we cannot define, but from which we know exactly what we mean and which we talk about with others as if we could be sure that they too know what we mean – although we can never know whether they mean the same thing?

Our considerations must begin with the insight that there is not only in our mind "something" that we cannot define or describe, but that this applies to *all of reality*. Everything that exists contains something undefinable.

E.g. my desk: what is it? What is it made of? It is made of wood. Wood consists of cellulose and lignin and some other substances. All of these substances are made up of different types of cells.

Cells are made up of molecules, which are made up of atoms, etc. But at some point, the disassembly stops. In current physics I end up with some elementary particles, and when the question is now asked *what* these elementary particles *are* and *what* they are *made of*, there is no longer an answer.

If you ask a physicist these questions, she will tell you how the particles behave and what they do, or she will explain how they are represented mathematically, and she probably won't even realize that she hasn't answered your question at all.

So it is a fact that the existence of *every object* involves something that cannot be defined and described. However, this fact has almost completely disappeared from our consciousness: it plays no role in everyday life, and physics has limited itself to describing the *behavior* of objects for so long that the "what is" question has been forgotten, and with it at the same time the fact that all really existing objects have "something" about them that cannot be defined.

However, this is the starting point for the answer to our question: *"Why does our mind contain sensations",* because it changes the question in a decisive way.

We no longer ask ourselves:

"Why is there something indefinable only in the mind and nowhere else?"

but rather:

"Why does the indefinable, which exists everywhere in reality, change its character when it appears in the mind?"

Thus now the question is no longer the reason for the *existence* of this indefinable, but rather the reason for its *change*.

In the first version the question cannot be answered. In this (wrong) form it leads to the strange hypotheses that we made fun of a little unfairly at the beginning. (Was it really unfair?)

However, in the second version the question can be answered. Unfortunately, the proof cannot be provided in the form of a casual chat, but an intuitive understanding is possible.

But to achieve this, we have to move from the "what is" question to the "why" question.

I would like to explain what I mean by this with an example:

Let's look at the earth. It exerts *gravity*, i.e. it causes all objects to accelerate towards it. *How* this happens, i.e. how bodies behave due to this influence, is a subject of physics. But the question of *why* the Earth exerts this influence cannot be answered by physics and, like the "what is" question, it has not been asked for centuries.

On the one hand, the "why" question is just as unanswerable as the "what is" question, on the other hand, these two questions are most intimately intertwined:

Why the Earth exerts gravity must indeed *follow* from *what it is* – and moreover: it must be *inseparably* linked to it, because the Earth can never stop exerting gravity.

So, what the earth *is* and what it *does* form an inseparable unity.

Therefore the two questions: "*What is* the Earth" and "*Why* does it exert gravity" aim at the same indefinable element of its existence.

We call this indefinable element of the earth "mass". Thus "mass" is just a designation and not a reason.

What happens in the solar system depends on the mass of the bodies in the solar system. And I repeat: although we are able to describe and calculate quite precisely what will happen in the solar system, we still have no idea *why* it is happening.[74]

What we have demonstrated with this example applies to *all* objects and systems. Just as we don't know why the Earth acts gravitationally, we also don't know, for example, why an atomic nucleus acts electromagnetically. Like "mass", also "electric charge" is nothing more than a name. The mathematical definition refers only to the question of *how* the charge affects other bodies, and not to the question of *why* it does so.

If these statements apply to all systems, then we can – no: we *must* apply them also to ourselves, and that means that you have to ask yourself:

"What drives my thoughts and actions? *What* is it that motivates me? *Why* am I even active and not just sitting around?"

The answer is simple: it is *sensation*. Sensation is what drives you.

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[74] Unless one accepts the explanation of gravity from Chapter 4.

Just as mass or charge, sensation *cannot be defined*, and just as *mass and gravity* form an inseparable unity, so too do *sensation and information processing*: every element of the mental activity has a *sensation* content and an *information* content.

This brings us almost to the end of this semi-formal chat. I hope the following facts have become a little clearer:

Sensation has the same status for a system that produces mind as *mass* or *charge* have for a physical system: it is the *driving force* of what happens in the system.

Sensation is related to *information processing* in the same way as *mass* is related to *gravity:* in both pairs, the two elements are *inseparably linked*.

Like *mass*, also *sensation* cannot be defined as that what it *is*.

But there is an essential difference here:

Unlike mass, with sensation we actually know *what* it is: Strictly speaking, sensation is even the *only* being of which we know what it is, because our consciousness is an incessant stream of qualia – i.e. of our mental states, which we have recognized as *inseparable units of sensation and information*.

And so we actually know that sensation is not something physical.

However, this knowledge is not knowledge acquired through logical reasoning but rather intuitive certainty about what is immediately given to us: sensation.

13. Primordial Scenario ⟶ No Robot Consciousness

Preliminary Note

The content of this chapter follows directly from the statements and conclusions of the previous one. However, because of the current importance of the topic, I consider it necessary to carry out the proof in full. So I will present all required facts and arguments here again, albeit shortened.

I have decided on a two-stage implementation. For the first, short version of the proof, the expansion of the scientific view presented in the section on free will is sufficient: there we have freed the mental level of reality from the grip of physical causality, by showing that the *activity of reality* cannot be imitated by logical or mathematical procedures, so that the claim that everything *follows from* physical initial conditions and laws cannot be maintained. Under this condition, it is possible to understand mental states as *self-dependent, dominant objects*, which is made concrete by conceiving them as *attractors* of the dynamics of the neural network. The sequences of these states – i.e. the mental processes – can thus be determined as *causal layer* on which this dynamic depends.

However, in order to secure the proof against all possible refutations, it is necessary to analyze the whole scenario on the basis of the expansion of materialism, which was the subject of the first chapter, and to reconstruct it conceptually. It is then not enough to shift causality "upwards" – into the mental area – but rather the complete concept of reality is required, according to which reality is *more* than a describable sequence of states that (in principle) could be reproduced with any degree of precision.

13.1. First Version (Short Form) of the Proof

In recent years, the efficiency of artificial intelligence has been impressively demonstrated. In scenarios whose states and changes are fully definable – such as in the games Chess and Go – AI systems are now far superior to humans. However, neural networks capable of learning, which – following the example of evolution – permanently optimize themselves by selecting the most successful variants, achieve considerable success in areas of the real world too.

So it is understandable that the hopes (and fears) of AI now go much further: Is it possible to create a system that equals or even surpasses human performance not only in specific areas, but also *in total*? Can an information processing system be constructed that has *consciousness*?

In any case, there seems to be no *absolute* obstacle for the realization of this vision. Obviously, also the brain itself is an information-processing system. And this applies also to all sub-structures of the brain, including those that are necessary for our feelings – they all are nothing other than biological modules that receive information in the form of electrical impulses, process it and pass it on to other structures.

So if one assumes that it is precisely this information processing in our brains that creates mind and consciousness, then it seems obvious that it is only *technical difficulties* what separates us from creating a robot with consciousness – albeit on such an enormous scale, that it is currently uncertain whether the construction of such a robot will be possible in the foreseeable future.

Here, we will ask ourselves whether it is really only technical difficulties what prevents or delays the creation of a conscious machine, or whether there are also obstacles *of principle* – and by that I mean obstacles that *in no way* can be eliminated.

Let us assume we have succeeded in constructing a robot that has an artificial neural network whose structure corresponds to that of a human child. This neural network is supplied with information from the outside world and from the body of the robot via artificial sensory organs in the same way as in a human. In the function that simulates the connections between the neurons, we have implemented all the changes that occur in natural neural networks, i.e. the amplification through activity and the reduction through non-activity, and also the modulation of these connections through chemical systems. This seems to ensure that the robot is capable of *learning* in the same way as a human: it will have a *memory*, it will form *representations*, it will be able to *think*, etc.[75]

Let's call our robot ***Joe***.

How will Joe evolve? Will he have feelings? Will he develop consciousness?

Given the above conditions, it actually seems natural that the answer has to be: ***Yes, he will***.

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[75] The prerequisites of the thought experiment are intentionally so extremely idealized, because the only question here is whether our project will fail even if *all* technical problems have been solved. So the robot *should be* a perfect simulation. (For that, the list of his skills is still rather incomplete.)

Yet this answer is wrong. Rather, the following is true:

Even if Joe were the best possible simulation of a human, he would feel nothing and would have no consciousness.

Why is that? The proof is surprisingly short and simple.

First we define ***simulation***:

"Simulation" is the reconstruction of the dynamics of a really existing system in another system constructed for this purpose.[76]

For an illustration, let us look at simulations of our solar system.

In earlier times, mechanical simulations were very popular – often beautiful constructions in which balls made of wood or brass imitated the movements of the planets around the sun. Today we will rather find computer simulations in which suitable algorithms generate a video of these movements.

In any case, ***it is not gravity*** what drives the simulation – as would be the case in the real system. And it is immediately evident that it can never become gravity, no matter how much the accuracy of the simulation is increased. Obviously, gravitation as driving force of the dynamics would only be preserved in a *replica* of the solar system. (In this replica, the representations of the celestial bodies would have to appear with the masses of the originals!)

Therefore applies:

In contrast to the "replica" of a system, the dynamics of a simulation is <u>not</u> caused by the same driving force as the dynamics of the original system.

The dynamics of a system is based on the *causal relationships* through which the objects of the system are linked to one another. For the construction of a simulation it is therefore necessary to determine the *causal level* of the system, i.e. the level on which the processes take place that cause the dynamics of the system.

In the solar system, this is trivial, since there is only one single "level": the objects are the celestial bodies, their movements are caused by gravity.

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[76] *Dynamics* means the development of the *state* of a system; *state* is the totality of the attribute-values of all objects of the system at any given point in time.

In the human neural network, on the other hand, we find three levels: the physico-chemical, the neural and the mental level. In the previous chapter – in the section on free will – the *mental level* has been determined as the *causal level*.

I will briefly repeat the reasoning:

The physico-chemical level: Here an enormous number of processes run simultaneously, many of which influence one another. Therefore, there is absolutely no method for exactly predicting the future development of the network. The assertion: "What happens in the network *follows* from initial conditions and physical laws" is wrong.

The same applies to the neural level.

The mental level: Neural patterns that represent or mean something can be produced by the network without an external cause. They must therefore be understood as *attractors* of the network.[77]

It applies:

An attractor determines the dynamics of a system if the state of the system lies in the catchment area of the attractor.

The state of the neural network of a human is *always* in the catchment area of an attractor: from *any* state, the network will immediately adjust to a pattern that *means* something.

So it can be claimed:

In the human neural network, the mental level is the causal level. Mental processes determine the dynamics of the network.

Now we have to ask:

What is the driving force behind the dynamics of the mental area? What drives us to think and act the way we do?

The answer is:

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[77] *Attractor* is a system state or a sequence of system states – so to speak a (static or dynamic) "pattern", towards which the system *necessarily* evolves and which it then maintains for a certain period of time.

Sensation.[78] **Sensation is the driving force of the dynamics of the mind. Information without sensation is indifferent and therefore *passive*.**

Since the mental area is the *causal* level of the neural network, it follows:

Sensation is the driving force of the dynamics of the human neural network.

Previously, we have established that exactly *that* what drives the dynamics of a really existing system, is *not* transferred to a simulation of this system. If we now apply this fact to the simulation of a human neural network, then we get:

When a simulation of a human neural network is carried out, sensation is not transmitted.

This means:

In the simulation, there is no sensation but only information.

And here, too, applies what we previously found in the simulation of the solar system regarding gravity: No matter how far the accuracy of the simulation is increased – what drives the dynamics of the simulation will never become sensation.

In other words:

The simulation – the robot – does not feel anything. It cannot love or hate, want or not want. Our robot Joe is not a sentient being but a zombie.

If sensation is absent, then there is no consciousness either: Even the most abstract intellectual activity is carried by an interest and guided by a motive, and both interest and motive are descendants of sensations from which they cannot be separated. So it would be absurd to ascribe consciousness to a robot without sensation.

This is the answer to the question why robots will never have sensations and consciousness.

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[78] *Sensation* must be understood here in the broadest possible sense: It stands for everything that goes *beyond* information in a mental state, i.e. for that which cannot be *defined* but can only be *felt* and *experienced*. (Two examples: the frequency of the color red can be defined, but the sensation *red* cannot; the strength of a pressure can be defined, but the sensation *pain* cannot.)

13.2. Ontological Expansion and Validation of the Proof

Although the short form of the proof we have just performed is complete, it has a weakness:

Since it is not entirely clear why the proof works, it might appear that it would not include an AI system, whose structure is sufficiently similar to the structure of a human (or animal) neural network, if that system was realized through *hardware* and not just through software on a conventional computer.

This deficiency can be eliminated by relating the proof to the premises of the description of nature that we developed in Chapter 1 and applied in the previous chapter on free will and qualia.

The expansion of the scientific view of reality, from which we start in the following considerations, is logically compelling and basically self-evident. Nevertheless, it has so far remained almost completely unnoticed. As a reminder – it reads:

Really existing objects are <u>active</u>, objects in a description are <u>not active</u>. Thus, the existence of real objects must include something that objects in a description lack.

We have called this element of the existence of real objects ***substance***. Substance is therefore that from which the ***activity*** of real objects emanates. Although the necessity of the existence of the substance can be easily realized, it is still not possible to think ***what*** it is.

The element of the existence of real objects that we can perceive and describe is the *kind* of their activity, i.e. how they present themselves and act on their environment. This element of their existence we have called ***accidents***. Natural science deals *exclusively* with accidents.

Therefore the following applies:

Really existing objects consist of substance and accidents, whereas objects in a description consist only of accidents.

Since an object cannot *cease* to be active in its characteristic way, ***substance and accidents form an inseparable unity***.

So much for our preconditions.

Now we need the following **<u>definition</u>**:

What an object is due to the inseparable unity of its substance and accidents, we call its <u>essence</u>. The activity that results from this unity we call <u>essential</u>.

(Thus the ***essential activity*** of the Earth is to exert gravity.)

The purpose of this definition becomes immediately clear when we now turn to simulations.

For example, consider a mechanical simulation of the solar system in which the model bodies are moved through mechanical devices – chains, gears, shafts, etc., thereby mimicking the movements of the celestial bodies.

The *essential activity* of the model bodies would obviously be to *exert gravity.*

But it is *not the mass* of the model bodies what drives the dynamics of the simulation – that is, what causes the intended movements of these bodies – but *the mechanics constructed by us,* which must then be *activated*, electrically or mechanically (e.g. by turning a crank).

To express this fact, we will refer to this type of activity as ***supplied activity***, in contrast to the just defined ***essential activity***, which happens ***by itself***.

As a consequence, the definition of a simulation given in the first version of the proof of the impossibility of robot consciousness changes in the following way:

The dynamics of a simulation is <u>not caused by the essential activity</u> that arises from the inseparable unity of substance and accidents of the objects of the simulation, but <u>by supplied activity</u>.

The accidents from which the dynamics of the simulation is formed are *substance-less:* the substance of the objects of the simulation is *not the substance that belongs to these accidents* and with which it forms an inseparable unity, but only *their material basis,* from which these accidents can be removed anytime.

The final building block of our proof is the proposition on page 270:

As long as accidents of higher complexity can be described as functions of accidents of lesser complexity, the associated substance remains the same. If this functional dependence disappears, then the substance changes. For us it appears then as a new, second substance.

We also need the proof of this theorem. It goes like this:

Initially, we established that the accidents of any evolutionary level can be reduced to accidents of lower levels, with the exception of the accidents of the highest level, i.e. the level of the mind.

We have called the totality of physical accidents ***first accident*** and their associated substance ***first substance***, the totality of mental accidents ***second accident*** and their associated substance ***second substance***.

Now the following applies:

Substance and accident always form an *inseparable unity*.

The first accident is *inseparably* linked to the first substance.

If complex accidents can be step by step reduced to simpler accidents, then this means that they can ultimately be reduced to the first and simplest accident.

For us, however, *reducibility* is tantamount to *ontological identity*: if B is reducible to A, then B ***is*** actually A. So if a complex accident is reducible to the first accident, then it ***is*** actually the first accident, and then it is *inseparably bound* to the first substance.

As long as the accidents are reducible, the associated substance remains the same – it is then still the *first substance*.

But if the chain of reducibility to the first accident is interrupted by the appearance of a new, irreducible accident, then this new accident differs from the first accident and from all other accidents that can be derived from it.

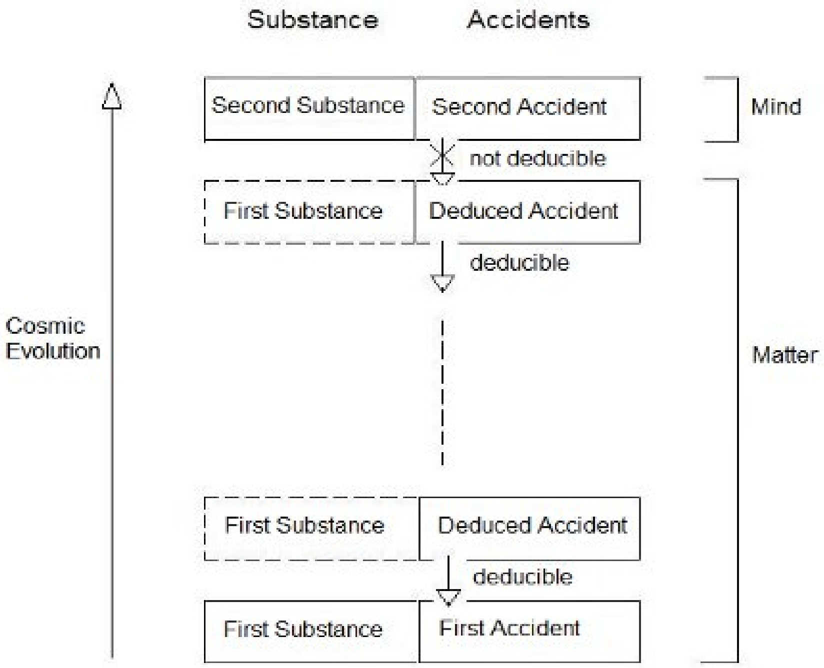
However, due to the *inseparability* of the first substance and the first accident, it applies:

If the substance of an object is the first substance, then the associated accident must be the first accident.

And from this follows:

If an accident appears that is different from the first accident, then the associated substance must also be different from the first substance.

Here is a sketch for illustration:



The crucial point in our argument is that the transformation of the essence of being can only occur if the dynamics of the system arises from the *inseparable unity* of substance and accidents. *Only then* does the transformation of the associated substance follow from the fact that the accidents are no longer reducible to the first accident.

If, on the other hand, the dynamics of the system is based on *supplied activity,* then the accidents are *substance-less*, and the substance that belongs to the objects of the system *does not form an inseparable unity with these accidents*.

And this means: There is no reason for the transformation of this substance. It remains *first substance.*

In other words: The *essence* of the simulation remains *physical*. The simulation remains an information processing system without sensation.

The metamorphosis of matter into mind does not take place.

The just mentioned condition that the dynamics of the system must arise from the *inseparable unity* of substance and accidents, does not only apply to the last, i.e. the mental level – it must be satisfied on *every* level that develops during the evolutionary rise from matter to mind. If on any of these levels the dynamics of the system is not caused by the *essential activity* of the objects but by *activity supplied from outside*, then the unity of substance and accidents is torn and the transformation of the essence of being can no longer occur.

So what does this mean for our proof that robots cannot have consciousness?

For AI systems that are implemented using software on conventional computers, the proof is valid without exception: the use of software is always associated with supplied activity.

But what about a replica of a biological neural network that reproduces the neural (analog-digital) input-output law using suitable hardware and whose structure corresponds to the structure of the entire network, so that it could be assumed that the sequence of states of the *constructed system* would almost be identical with the sequence of states of the *biological system?* Could the transformation into sensation take place here?

The answer is clearly ***no***. The condition for the transformation is not met: the dynamics of the replica is *not caused by* ***essential activity*** *but by* ***supplied activity***.

The problem is that from the usual scientific view of reality *this fact cannot be understood at all*.

In this view, reality is *equated* with a (describable) sequence of states, and it must therefore be expected that the increasing convergence of two sequences of states ultimately leads to their identity.

However, in the expanded materialist view that we have presented here, the concept of existence is augmented by an element that takes us beyond the realm of the describable.

This means that all our descriptions and ideas about the processes in nature are necessarily incomplete. So to speak "behind the scenes" of the part of the stage that is accessible to us, something happens, which is either completely hidden from us or can only be recognized and understood through inference from the part of reality that is accessible to us: the accidents. Here, reality is *more* than a sequence of states.

In the context of our considerations, this means:

From the approximate identity of the state sequences of the natural system and the artificial system cannot be concluded that also their essence is approximately identical.

Concretely: The substance of the two systems can be quite different despite the extensive identity of their states:

In the *biological system*, the substance is *inseparably bound* to the accidents of the system and is therefore *transformed into the mental substance sensation***.**

The *constructed system*, however, is driven by *supplied activity,* and therefore here the substance stands in a merely constructed and *by no means inseparable* connection with the accidents of the system, so that it remains *physical substance* and is *not transformed into sensation*.

The result of our considerations is the following **<u>Proposition</u>**:

It is not possible to construct a robot that experiences sensations and has consciousness. Neither in a simulation nor in the replica of a system that produces mind can the transformation of matter into mind take place.

There is no ghost in the machine.

Thus only *artificial intelligence* can be constructed and not *artificial mind*.

Does this mean that it is impossible to create artificial mind at all?

No. Our argument only excludes the possibility that mind can be *constructed*. However, the definition of the term *replica* can be expanded to include artificial evolution, i.e. an evolution that is designed and controlled by us.

In this case – just as in natural evolution – the condition could be met that the respective system activity is always *essential*. If we do not intervene at any point in this artificial evolutionary process through constructions or by supplying activity, but limit ourselves to controlling and accelerating the development, then at the end of this evolution there could be a system that produces mind.

However, no one can know whether such an artificial evolution is possible, or whether the path that nature has chosen is the only viable one.

In any case, it is clear that the creation of artificial mind remains a very distant, perhaps never achievable future, if it is not impossible at all.

14. Primordial Scenario → Reality and Mathematics

This chapter aims to answer the questions of what reality and mathematics are and how they relate to each other.

The last question breaks down into two parts:

1. What is the difference between reality and mathematics?

2. What is their connection?

First we will determine what reality and mathematics are. For the reality, we have already discussed this in detail in several chapters. It will therefore suffice to recall and generalize our results in the form of a brief summary. Then we will clarify what kind of existence mathematical objects and propositions have.

Since their difference makes it particularly clear what mathematics and reality are or are not, we will not treat the question of their existence completely separately, but rather consider it based on this difference.

14.1. What Is Reality?

This book began with an expansion of the materialist worldview that I call *minimal metaphysics: metaphysics* because it adds something, which is unthinkable and lies beyond physics, to the physical, describable and conceivable reality, and *minimal* because this expansion only contains exactly that additional element of reality without which the concept of reality would obviously be incomplete: *activity.*

Activity is the distinguishing criterion between reality and description: real things are *active*, things in a description are *not active*.

That part of the existence of real things from which their activity originates – for lack of a more suitable word one could say: that which they consist of – we have called *substance*. Substance, then, is what makes real things active and what things in a description lack.

The part of the existence of real things that natural science deals with – how things present themselves, behave and act – we have called *accidents*.

So the following applies:

Real things consist of substance and accidents, things in a description consist exclusively of accidents.

This difference is so trivial and self-evident that one might initially think that it does not need to be taken into account.

However, that would be an extreme misjudgment, because its explicit definition and integration into the description of nature forces changes in the scientific and philosophical worldview to a completely unexpected extent. It leads to a re-foundation and complete restructuring of the entire descriptive system and leads us to a significantly expanded understanding of reality, which includes the realms of matter, mind and natural laws.

We will start with the consequences for physics. However, I will only present a brief summary here – for the reasons and derivations of the individual results I refer to the respective chapters.

What the substance *is* can neither be described nor imagined.

However, statements about it are possible. From these statements an equation can be derived which, due to its position in the structure of the description of nature, must be understood as representation of the process that creates reality.

The equation deals with metric facts. It reads:

$$\frac{d\sigma}{dr} = \pm \frac{d\zeta}{dct} \qquad (0)$$

In words:

The spatial change in the metric density of length (or angle) is equal to the temporal change in the metric density of time.

This means:

Reality is a differential web of metric changes in space and time that are mutually dependent. Everything that exists and that occurs – every object, every interaction, every process – is a pattern of these changes.

Equation (0) leads to equation (1). If σ is understood as metric density of the *length*, then equation (1), together with the simplest possible metric assumption – a spherically symmetric metric compression – leads to a theory of gravity (which in the case of galaxies results in a much higher rotation speed).

If σ is seen as metric density of the *angle*, then – again combined with the analogous simplest metric assumption – it leads to electromagnetism and the atom structure.

Since equation (0) describes the creation of all reality, the entire logical structure of physics must be related to this equation and additional metric assumptions. I refer you to the outlines on pages 6 and 13, where it is shown for which areas of physics this assertion applies.

Currently it is unclear whether the new justifications and theories will prove successful. Thus, for the time being, the extent to which the presented arguments and deductions are conclusive is left to the reader's assessment.

What is particularly important for the topic of the current chapter is how our understanding of reality changes by taking into account the difference between reality and description:

Let us assume that we have a complete and correct mathematical description of physical reality: wherever we look, everything corresponds exactly to our equations; We can observe everywhere how the future develops from the present, in complete accordance with our descriptive system.

Does this total agreement between observation and description mean that in our descriptive system the future follows from the present?

Because of the difference between reality and description that was presented in Chapter 1, the answer is no. As follows:

The fact that reality is *active* means that at every position and at every time exactly what is to be expected according to our equations occurs *by itself,* the future arises *by itself*.

In contrast, in our descriptive system *nothing* happens.

Since the description lacks *activity*, the future does not arise by itself – it must be *derived*. Obviously, in the description system the missing activity must be replaced by a mathematical or logical procedure that enables this derivation.

However, in scenarios in which numerous objects move at the same time (or numerous processes take place at the same time) that influence each other – which, strictly speaking, is *always* the case –

no such procedure exists. It is not possible to include the constantly changing influences in the calculation of any process.[79]

This means:

The claim that in the description the future follows from the present is wrong.

And in the reality itself? In fact, all we observe is that the future follows the present. Since it occurs in accordance with our physical laws, we feel compelled to replace the "follows" that we observe with the "follows from" that we associate with the existence of laws.

However, if we want to justify this substitution, we are forced to express the "follows from" through a series of logical steps. But since there is no mathematical procedure, we are finally forced to take back the "follows from" of which we were so sure and limit ourselves to the "follows".

Even for the reality itself, it cannot be claimed that the future follows from the present.

In other words:

Physical causality is incomplete. There is room for other kinds of causality.

Because of the difference between reality and description, it was clear from the beginning that reality is *more* than physics or mathematics. What this "more" means has now become more concrete:

As we have demonstrated in Section 12.1 on free will, there are systems in which causality can not be assigned to the physical level, but to a level of higher complexity that consists of objects that are themselves made up of physical objects. This level then has its own, self-dependent dynamics on which the development of the system depends.

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[79] This is not just a *technical*, but a *fundamental* (absolute) limitation: even a Laplacian demon with infinite resources of space, time and information could not carry out this calculation: Let us consider the example of gravitating bodies, which begins on page 247 below and the calculation of which is described on page 249. In order to *accurately* determine the future of this system, the demon must perform the calculation for infinitely small consecutive time intervals Δt. If the interval boundaries are as close as the *real* numbers, the calculation will not be finished even in an infinitely long time, but if they are *less* close (like the rational numbers, for example), it will happen that an instability is missed that occurs *between* two time points of his calculation.

With this, we have entered a realm of reality *that is no longer physical* – in the sense that its laws are not physical laws, and the variables that go into these laws are not physical variables.

In the case of human neural networks, causality shifts into the mental realm.

This is a necessary condition for establishing free will. However, the reasoning required for that is based on a further change in our view of reality. It concerns the question:

Is the reality deterministic or not?

If you take into account the physical part of my explanations, then it is clear that everything that happens cannot happen otherwise.

We have even eliminated the quantum mechanical objective indeterminacy by assuming that a continuous, differentiable level of metric waves exists below the quantum mechanical description. The indeterminacy is then no longer objective but turns into "normal" probability, i.e. it can be understood as a statistical phenomenon that owes its existence to our ignorance.[80]

This means:

If there were an identical copy of the universe, then everything in this second universe would be exactly the same as in the original. There are no branches in the course of events. This is usually considered as definition of determinism.

However, this definition is not applicable to our reality, because in this reality *the future does not exist before it occurs*, or, in other words, because ***the future is not contained in the present***.

The assumption of determinacy requires that there is *something, which* determines the future. In other words, the future ***must*** be contained in the present. Determinism therefore presupposes derivability – but only derivability *in principle* and not *in fac*t.

But our reality is indeed *not* derivable *in principle:* the future does not *follow* from the present, it merely *arises* from it.

As we showed in 12.1.5, the reasons why something happens are in some cases non-existent – indeed not even predictable – before they develop.

[80] However, it is not necessary to include this hypothesis. If indeterminacy is objective, then there are no hidden parameters that influence events – not even in more complex layers of reality. Then it applies to all world courses which are possible as a result of indeterminacy that they are not contained in the present. All arguments and proofs therefore remain valid.

In this way, we were able to establish free will without postulating a fork in the course of the world.

So we have come to the following changes in our understanding of reality:

1. Physical causality is incomplete. There is non-physical causality in complex layers of reality, based on non-physical laws and variables.
2. The future is not contained in the present. It does not exist until it happens. Although only one future is possible, reality is not determined because there is nothing *that* determines it.

It follows immediately that reality is not a mathematical system. If one were to assume that states of reality correspond to statements in some mathematical system, then reality would, due to its inderivability, permanently produce states that correspond to Gödel statements of the system, i.e. which cannot be derived from the axioms and rules of the system.

This means:

Reality transcends every mathematical system.

So far we have described the changes that result from reality being *active*. The analysis of the concept *substance* that we discussed in Section 12.2 about qualia then leads to further, even deeper changes, which we referred to in Section 13.2 as changes of the *essence* of being.

As it turns out, *sensation* is a manifestation of substance. Its existence can be justified by the appearance of non-derivable accidents in the realm of the mind.

This non-derivability of accidents is the reason that *for us* the essence of being appears transformed.

Therefore a further change follows:

3. The analysis of the term "substance" makes it possible to understand mind as part of reality, in exactly the form in which it is intuitively given to us: as stream of qualia, accompanied by sensation and consciousness and endowed with free will.

For understanding mental phenomena, the scientific approach is not suitable. Here, a description adapted to the nature of the mind – the inseparable unity of sensation and meaning – is preferable. Mathematics, physics and chemistry only have an assistive function; The attempt to grasp mind in a scientific way reveals the metaphysical deficits of mathematical and scientific concepts and methods.

Since, in the scientific perspective, *mind* and *information processing* are identical – and therefore also artificial mind and artificial intelligence – it was necessary to show that robots cannot have mind.

The proof was carried out using precisely the concepts that have no place in a scientific description of reality: *substance* and *activity*. Only these concepts make it possible to define the differences between mind and information processing and to determine their respective requirements.

On this basis it can then be shown that there is no ghost in the machine.

The changes in the view of reality that result from our "minimal metaphysics" can be summarized as follows:

On the one hand, this minimal metaphysics turns out to be unexpectedly fruitful for physics: through it, a new basis for physics can be created, which leads to theories that agree with the previous theories in standard situations, but in scenarios where the old theories fail they open up alternatives. In any case, the new theories and interpretations enable a much better understanding of what is really going on in physical systems.

On the other hand, reality has moved a little further away from physics and mathematics. In some cases causality does not remain in the elementary, physical level, but shifts "upwards" into a more complex layer of reality, in some cases it remains incomplete at all.

We have realized that systems we construct can never be identical to real systems because they lack substance. When we attempt to construct mind, we only create an information processing system that remains insensitive and has no consciousness.

What turns out to be a fundamental limit of what is feasible, however, at the same time allows us to understand *what we are:* beings with mind, and *what we are not:* intelligent automatons.

Only through our expansion of the concept of reality we can understand ourselves as part of nature – exactly as we *really* are, and without having to reduce ourselves to the limited model that natural science has constructed of us: a collection of optimizable and controllable algorithms.

14.2. What Is Mathematics?

1. The Origin of the General

Since mathematical objects are *exclusively* general, we will first deal with the question of how the general comes into the world – a world, which seems to consist *exclusively* of individual cases.

So how does the general come into reality?

In two ways. In the realm of mind, the reason for its occurrence is as follows:

Mental processes are sequences of mental states. Mental states are neural patterns that represent or mean something. Since the neural network can produce them also without external causes, they must be understood as *attractors* of the dynamics of the neural network.[81]

An attractor has a catchment area. This means that it is not just a single, precisely defined input – such as the perception of a specific object under specific conditions – that causes the attractor, but rather every input that lies within the attractor's catchment area.

In this sense, the attractor provides a definition for similarity. From this follows that a neural state cannot represent the *individual* at all, but only the *general:* it represents not just the *one*, precisely defined object, but *all* objects that are sufficiently similar to this object (e.g. the object itself in a different position) to be in the catchment area of the attractor.

This also applies to meta-representations, such as concepts.

In other words:

An attractor does not represent or mean a ***single*** *object, but rather a* ***set*** *of objects.*

From the determination of mental states as attractors of the neural dynamics follows that, for beings with mind, the world is *divided into sets*.

This shouldn't be understood too abstractly. It simply means that the shepherd knows that there are sheep and wolves; And the fact that he knows this and recognizes both animal species immediately is not thanks to any analyzes or calculations, but rather to the way his neural network represents the world.

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[81] In Section 12.1 on free will we have presented this in more detail.

Therefore in the mind there *is* only the general.

So the question is how we can actually perceive and recognize the individual. But that is easy to answer. Direct recognition is usually enough. If is not enough, then specifying the location and time is sufficient: My neighbor is the one who lives next to me. The person who works next to me is my colleague, etc. If these determinations are still not sufficient, then a feature analysis can take place, but each feature is again an attractor.

So much for the question of how the general gets into the mind: *the mind is the realm of the general*.

This brings us to the question of how the general comes into material reality.

If it didn't exist there – i.e. if all observed facts were just individual cases – then things couldn't behave according to laws. Since the logical connection between cause and effect *cannot be found* in individual cases, it *must* lie in the general.

So how does the universal come into material reality?

We answered this in Chapter 11 as follows:

A necessary condition for being able to *distinguish* the individual from the general is the existence of scales or the definition of units of measurement. Prerequisite for scaling is reference to anything that exists. (For example, the unit of length can be defined by the wavelength of a material object.)

Therefore, the origin of the general must lie *before* all being, i.e. where – due to the lack of scaling – the individual and the general are indistinguishable and therefore equivalent: the *origin of being* must therefore also be the *origin of the general*.

We analyzed the *origin of being* in Chapter 1 and derived from this analysis the equation that describes the creation of reality.

In Chapter 11 we then showed that this equation is also the origin of the general in the material reality, because it itself – since it *creates* reality – is ontologically *prior to* reality and is therefore both individual and general at the same time, and therefore everything, what it produces – every object and every fact – inherits this ambivalence from it: everything that emerges from it becomes an *individual* that carries the *general* within itself.

If the knowledge of one of the two sources of the general were missing, then the assumption of an independent, Platonic existence of the general would be unavoidable. However, like any kind of dualism or pluralism, also this assumption would fail due to the insolvability of the problem of interaction: the question of how law and being are connected – how the general can *affect* the individual (the respective being) or in what way it can be *in* it – could not be answered.

We will now clarify what existence mathematical objects and propositions actually have.

2. What Existence Have Mathematical Objects and Propositions?

Mathematics begins with counting.

So the *natural numbers* are the first mathematical objects. What existence do they have?

Let us first ask ourselves how it comes that we count.

Basically, we have already answered that: we have established that for beings with mind the world is divided into sets.

However, numbers are nothing other than properties of these sets. For example, the number 2 is the property that is common to all sets that contain as many elements as I have hands.

This means that numbers are among the fundamental, *immediately given* elements of the experience of beings with mind – the shepherd knows that 2 sheep are 2 sheep (and not 1 or 3), and he knows this even *before* the concept of number exists, even before the number 2 itself exists.

In other words: *counting is a fundamental act of any sufficiently developed mind, which occurs in such a mind with necessity.*

So what kind of existence do the natural numbers have?

They are not part of "nature" – there are no numbers in the material reality. It's *us* who count. If the term "natural numbers" is justified, then only because it is in *our* nature to count.

This means:

Before evolution produces beings with mind, there are no numbers. But if such beings exist, then numbers *necessarily* arise because they are part of the mental reality.

We have thus clearly determined the nature of their existence: they appear at a certain stage of natural evolution, not different than, for example, heavy elements, whose existence is only possible if there are stars heavy enough to create them. If this condition is met, then heavy elements are created *with necessity*.

Obviously, the same applies to natural numbers. If evolution has produced mind, then they arise *necessarily* because of the way in which material reality is represented in the mind.

Did they exist before? No. Also the heavy elements did not exist until they were produced by sufficiently heavy stars.

Numbers therefore do not have a Platonic existence, they do not exist "outside" of reality or "independently" of it, but can be understood as part of this reality, just like all other objects of material and mental reality.

In its initial development, mathematics follows the path that is set by natural numbers and simple arithmetic operations. And here again, the fact that 2 + 2 = 4 is a fact that is evident for a being with mind, even if it does not yet have any concept of numbers. After that, mathematics becomes the free play of the mind with objects and structures, which is a characteristic of the mental reality.

Mathematics is the most outstanding example of a special type of mental activity: the invention and elaboration of systems that consist, firstly, of a number of defined objects and facts and, secondly, of rules for how further objects and facts can be constructed from them.

What kind of existence these objects have, can be illustrated by the following example:

Let us assume we intend to weave a multi-colored carpet. The initial series is already before us, and we also have a complete set of weaving rules.

Let us now additionally assume that at some point during the weaving process the image of a lion appears on the carpet. The question is: Did this lion exist before the carpet was woven? If what this means is that the lion can be *produced* from the initial row and the weaving rules – in the sense that it is *included* in them – then the answer is yes.

Mathematicians face a question of the same kind when they come across mathematical theorems in the course of their conclusions. These theorems are apparently not invented, but discovered. They are "included" in the axioms and rules of the mathematical system in the same way as the lion in the initial row and the weaving rules of the Carpet system.

So it is clear what kind of existence mathematical objects and propositions have: they are elements of the mental reality – of systems that are conceived by beings with mind. If there is a process in the system by which one arrives at such an element in a finite number of steps, then it can be *discovered*, and therefore – in the sense mentioned above – it seems justified to claim that this element had already existed *before* it was discovered.

Mathematical objects and propositions therefore exist if and only if there is a system according to whose axioms and rules they are formed. By applying the rules to create new objects and propositions, they can be discovered. *Before* the existence of this system, they do not exist.

Thus what has to be said about the existence of mathematical entities reads as follows:

They are formed in the mental reality. Therefore, mind is a necessary prerequisite for the existence of mathematical entities. In short: without mind no mathematics.

However, many mathematicians and philosophers believe that mathematical objects and statements have a Platonic existence, i.e. that they exist completely independently, in the form of an independent reality. The reason for this is that mathematical truths appear valid regardless of their material realization. The ratio of the circumference of a circle to the diameter of this circle will always be π – and one is tempted to say: no matter which universe you are in or whether there is a universe at all.

Why is that? To clarify this, let us return to the elementary arithmetic operations with natural numbers. They come from the experiences made when dealing with objects: 2 sheep plus 1 sheep equals 3 sheep, and that is a law that applies regardless of whether there are sheep, and even regardless of what is being counted, i.e. independently of its material realization.

Does this law therefore have a Platonic existence? No. It can only occur when natural evolution has produced beings with mind that conceptualize the world and divide it into sets.

Did this law exist before it appeared in the mind? No. Nothing exists before it comes into being.[82]

Even mind itself does not exist before it comes into being. This would not change if it could be shown that mind arises *with necessity*, in the sense that every possible development of the cosmos

[82] If something can be *derived* from certain conditions (like the lion on the carpet), then its existence can be asserted as soon as these conditions are realized – that is, *before* its actual appearance. But if something does not *follow* from what precedes it, but only *arises* from it, then the assertion of its existence before its appearance is not justified.

must produce mind. Even then, it would be inadequate to claim that mind exists before it actually appears.[83]

The same applies to mathematical objects and propositions. They appear as a consequence of the relationship between mind and material reality. Only with the appearance of mind can they exist; before that they have no existence.

The question of whether numbers and elementary arithmetic operations are invented or discovered can only be answered with "neither-nor":

Are they *discovered*? No. They didn't exist before. Are they being *invented*? No. The development of the mind necessarily leads to their appearance.

Even if one assumes that every being that has a mind and is sufficiently capable of thinking advances to numbers and mathematics, this does not prove their Platonic existence. Rather, it is the interaction of mind and matter that necessarily leads to mathematics, and not the Platonic existence of mathematical concepts and statements.

3. Connection and Difference of Reality and Mathematics

Now that we have clarified where mathematics comes from and what kind of existence mathematical objects and statements have, we can judge the relationship between reality and mathematics based on their definitions.

What is mathematics? The science of relationships between objects and the thereof resulting structures.

What is reality? Relations between *existing* objects and the thereof resulting structures.

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[83] If one would assume that all objects that exist now or in the future already existed before they actually appear, then one would have to *start* the creation of reality with a state that itself already contains *everything* that will exist at some time point. That would then be the opposite of our "minimal" metaphysics – it would be exactly the kind of "maximal" metaphysics that has prevailed for thousands of years and was rightly rejected by the Enlightenment: the assumption of an entity that would have to be understood as "God" or "the Absolute". However, since the emergence of objects and facts can be *explained*, the assumption that they exist before their actual appearance is superfluous, and the just mentioned consequence of this assumption disappears.

If one assumes that there are laws in reality that regulate the relationships between objects (we have that even proven), then these definitions obviously result in a close connection between reality and mathematics, which is by no means mysterious or even incomprehensible, but basically self-evident.

At the same time, however, an important difference – or let's say a limitation – becomes apparent, which, in my opinion, receives too little attention and has therefore led to many wrong steps in physics in recent decades:

It obviously follows from the definitions that in the reality – in every system and also in general – only *one* structure is realized, while mathematics includes an *infinite number* of possible structures.

So if a problem arises in the logical structure of our description of reality, then there is probably only *one* way to solve the problem in exactly such a way that the solution corresponds to reality, but potentially an *infinite number* of ways to solve the problem purely mathematically (at least approximately) in a way that completely misses reality.[84]

Another important difference is the following:

Since all objects and facts in the mind are general, in the mental reality there are only statements about the general. Therefore, in the area of what is thought and what is perceived, laws can apply with complete precision, and true statements are possible.

However, the objects which these statements relate to do not exist in reality: in the material world there are no numbers, no circles, circumferences or diameters. None of the objects of mathematics are fully realized in the material world.

This means:

Applied to the material reality, true statements only remain true as long as the actually existing differences are ignored – such as when counting objects or calculating with objects: 2 sheep + 2 sheep = 4 sheep is an assertion, which is true because it does not contain the individual differences.

However, in the description of the dynamics of real systems, it is neither possible to ignore existing differences nor to fully capture them. So here, there are only approximations for reasons *of principle*.

[84] In the Final Report I will briefly comment on this topic again.

This brings us finally to the most important difference between reality and mathematics – the one which this book is based on and which has been discussed in almost all chapters:

Conceived as description system of reality, mathematics differs in a fundamental way from the reality itself in that it lacks the metaphysical quality *activity*. This results in a number of differences, all of which we have already discussed. I will again list them here:

In the mathematical description of reality, the future can *in some cases* be ***derived*** from the present.

In the reality, the future *always* ***arises*** from the present.

This "arising", which results from the *activity* of reality, is therefore much more powerful than the "deriving", indeed it is even in the literal sense *unimaginably* more powerful, because *activity* is linked to the presence of the *substance*, which can neither be imagined nor thought.

It is therefore clear that the unfolding of reality by far exceeds the possibilities of a mathematical representation. Reality transcends any mathematical system.

The fact that the future of reality arises from the present and cannot be derived from it means that reality is *not determined*. Even if there is only *one* possible future, reality cannot be determined because there is nothing *what* determines it.

Objects that exist in a mathematical system are created in an algorithmic way from the system's axioms and rules. In contrast, really existing objects can also arise in a non-algorithmic way.

Sometimes, in the course of its development through self-organization, reality approaches algorithmic describability – then mathematics and reality seem to touch each other – but without ever fully reaching it. And occasionally real structures or the trajectories of real objects resemble mathematical figures, such as circles or ellipses, without ever being entirely identical with them, and really existing systems sometimes resemble physical systems whose states are deducible from laws and initial conditions.

Ultimately, however, all natural laws – except for the *fundamental law*, which remains limited to the infinitely small – relate exclusively to idealized systems that are never fully realized. Natural laws, just like circles or ellipses, are themselves always idealizations; They are creations of the mind, elements of imaginary worlds that merely simulate the real world and, for metaphysical reasons, can never fully correspond to it.

4. The Origin of Reality and Mathematics

At the end of the second chapter we asked whether it was permissible to presuppose mathematics and logic at the beginning of the description of reality. Our answer was that no description can begin without presuppositions, and that therefore all that is required is that this inevitable epistemological circle is not destructive, and that the presuppositions made at the beginning lead to a description in which they themselves ultimately appear as understandable conclusions.

I close this chapter with the short form of such a "constructive circle", as it emerges from the contents of this book:

Everywhere and anytime the fundamental law is in effect and, through its activity, generates the ever-changing fabric of spacetime. Simple objects emerge in the form of spacetime patterns. They join together to form objects of higher complexity. This process is repeated several times. Finally, objects evolve that are capable of replicating themselves. With this, the biological evolution starts. At last, it leads to objects that are equipped with mind. These objects – or let us better call them *beings* – conceive the world through concepts which are universals. So they are led to the world of numbers. There, they discover the infinitely small and grasp it through the concept of the mathematical limit. Equipped with this knowledge, they turn to the *origin of everything* and understand how reality unfolds by changing from instant to instant according to the fundamental law.

So this is the short version of the story of the emergence of mathematics and how it arrives at the *origin of everything*.

Reality itself does not apply mathematics. Just as the blade of grass does not calculate where to move but simply follows the wind that touches it, also the reality does not calculate its next step but simply follows everywhere and anytime the differentially adjacent spacetime changes.

We, however, need mathematics to understand and describe how the fabric of reality unfolds, because, due to the lack of the *substance* and, with it, of the metaphysical quality *activity,* our descriptions are inappropriate to imitate directly what reality does.

15. Primordial Scenario ⟶ Transcendence, Meaning

When I wrote the book *The Concept of Reality*, it was quite natural for me to exclude the realm of the transcendent from all explanations and descriptions of reality. This objective was motivated by the principle of the "unity" or "completeness" of nature: everything that exists and everything that occurs is part of nature – in the sense that it is produced by nature itself and by nothing else; Whatever influences nature must itself belong to nature.

This means: ***There is nothing but nature***.

But what is nature? That, what we defined as reality in the previous chapter: *relations between existing objects and the structures that result from them.*

"Transcendence", on the other hand, is defined as that which lies outside of nature. Because of the above proposition, every kind of religion immediately disappears – at least its ontological part, without which it is no longer a religion – and also every kind of esotericism; All the projections that arise from desires, hopes and fears or simply from intellectual deficiencies, all the strange creations that stem from the need to fill gaps in knowledge that would otherwise be disturbing, disappear from the imagination of reality and take their rightful place in the gallery of the products of human fantasy.

To make this more concrete, here is an important example:

Mind can be understood as part of nature.[85] Thus there is no reason to assume a mind that exists independently of material conditions – an assumption that occupies a central position in all religions. Beings that possess this kind of mind would be outside of nature, and this simply means *they do not exist*.

In cases where it is not possible to find immanent explanations or to replace transcendent explanations with immanent ones, it is by no means allowed to give free rein to one's own creative imagination – especially not in the state of enlightenment, which is not only experienced by prophets and esoterics but occasionally also by physicists, especially when they think about the

[85] However, this presupposes the "minimal expansion" of the concept of nature, which will be discussed shortly afterwards.

quantum mechanical measurement process or the "theory of everything" – rather, it is then necessary to face ignorance and openly admit it.

So much for my goal at that time. However, it turns out that transcendence cannot be completely eliminated because the difference between reality and description – that difference that can be expressed through the concept pair *substance* and *activity* and which in this book is at the basis of the structure of reality – forces us to retain exactly that residue of transcendence that I called "minimal metaphysics" in the previous chapters:

Reality is ***active****, description is* ***not active****.*

Substance *is that from which the* ***activity*** *of reality originates.*

Substance and *activity* are transcendent because they themselves do not belong to the set of relations between ,existing objects, but are their prerequisites: Substance is prerequisite for existence, activity is prerequisite for relations (interactions).

In short: without substance ***nothing exists***, without activity ***nothing happens***.

The consideration of this transcendence leads to surprising and far-reaching changes in our view of reality. Though it is reduced to the necessary minimum, it is still – as is becoming increasingly evident – sufficient to answer some important questions, which have been discussed in several previous chapters. What is crucial for the current chapter, however, is the last of these changes, which maybe is also the most surprising one: the realization that sensation is a manifestation of substance.

To me this insight was surprising because previously I had assumed that mind is information processing and that therefore sensation – despite the ambiguity of its connection to information processing – would also occur in constructed systems with a certain degree of similarity to the biological model.

But the arguments in Chapters 12 and 13 show that this can never happen: no matter how perfect the AI system we have constructed may be, no matter how similar or even superior to our neural network it is, it still remains insentient.

However, the real importance of the insight that sensation is substance lies in the following:

Substance is transcendent. If sensation is substance, then sensation is also transcendent, and that means:

- Transcendence is not somewhere "outside" – it is *within ourselves*.
- Transcendence is neither inaccessible nor hidden – it is *revealed* to us, in fact it is even the only thing from which we know exactly *what* it is because it is part of ourselves. However, since sensations are not contained in any description, this knowledge is not *conceptual knowledge*, but rather *cognizance of what is immediately given*.

However, it is clear that these statements are not meant to justify the kind of transcendence previously criticized. They concern exclusively the indispensable minimum of transcendence determined by us and the form of transcendence derived from it: *sensation*.

By recognizing that sensation is substance, the status it has in our self-understanding and in our view of reality changes:

While it was previously possible – and also common – to consider sensation as the *accidental* part of our mind, this is now impossible: as *substance* of the mind, sensation is a necessary condition for the existence of mind.

In addition, as we showed in Section 12.2, sensation is also the cause of the mental dynamics, it is what drives our mental processes, just as mass is the cause of the dynamics of solar systems or galaxies: without mass there is no gravitational dynamics, without sensation there is no mental dynamics.

Substance is the logical and metaphysical prerequisite of all reality – *it produces reality*. In its manifestation as *sensation*, it is the logical and metaphysical prerequisite of mental reality – *it produces mind*.

The status of information processing also changes:

While it was previously possible to equate mind and information processing, this is now impossible. Information processing is just artificial intelligence, which remains insentient and without consciousness and can therefore never become mind.

Information processing is completely immanent. But the existence of mind presupposes transcendence: in the mental state, the *quale*, transcendence and immanence are inseparably linked; each quale is an *inseparable unity of sensation and information*.

Everything that is important to us comes from this connection: it always requires both elements of the Quale:

Cognition: Cognition requires motivation and knowledge. Motivation is a direct descendant of sensation; knowledge requires information processing.

Morality: Morality requires empathy – without empathy there is no reason to include the well-being of others in my intentions, and of course it also requires insight: without insight it would not even be possible to recognize the other as the one who is like me, which in turn is the basis for identification and thus also for empathy.

But I don't want to continue this essentially trivial list any further. I think it is clear enough that everything that is meaningful to us and therefore contributes to the meaning of our lives is deeply rooted in the two very different and yet inseparable components of our spirituality, and that only when we stay aware of this, we are able to be what we are.

At present, however, the ontological basis for understanding what *mind* is – and therefore also the prerequisite for understanding what *we* are – is missing. As long as the belief prevails that mind is *nothing but information processing*, this understanding remains excluded.

In the 18th and 19th century, the mechanical metaphor of man was extremely popular. The willingness of many people to recognize themselves in mechanically moved dolls, or to believe that a (supposedly) mechanically conducted chess machine *actually* has the ability to master the game of chess may seem naive from today's perspective.

Currently the electronic metaphor of man dominates. The impressive achievements of AI systems support this metaphor. However, our arguments prove that it is just as wrong as its mechanical predecessor – and what's more, it is more questionable or even more dangerous because its performance makes it much easier to identify with the electronic machine and even lets that seem attractive to some, and if we mistake ourselves for a simulation of mind, then we will undoubtedly approach such a simulation.

As just explained, everything that is important to us arises from the unity of sensation and information. If this unity is lost because we do not understand ourselves as spiritual beings but as intelligent automatons, then everything meaningful disappears and all that is left is an empty "more". It is then no longer about "the good" and "the truth", but only about power and money, no longer about spiritual goals and values, but only about "likes" and "followers".

The list of such bad consequences could be extended indefinitely. But I will close here and just take up the central theme of this chapter one last time:

Anyone who thinks that the area of the immanent with which natural science deals – in our terminology, the area of accidents – is incomplete and does not provide us with answers to the questions that are really important to us, I agree. However, I point out that in the transcendent or otherworldly you will encounter neither omniscience nor omnipotence, neither eternity nor bliss, but only you yourself.

There is no one there to answer but you yourself.

Final Report

In this book I have proposed solutions to a number of fundamental physical and philosophical questions and problems that were previously unresolved.

The methods by which I arrived at my answers differ in almost all cases from the usual methods.

Let's assume some of my solutions are correct. This would then suggest that the usual approach is not always the most appropriate way to solve a problem.

It is precisely this assumption that shall now be finally discussed.

For a long time – at least over the last 50 years – the development of theoretical physics has been determined almost exclusively by mathematics. For every problem, be it a contradiction between theory and experiment, or an inconsistency within a theory, or the incompatibility of two theories, a mathematical solution was sought. And not only that – the direction of the search was always dictated by the possibilities that mathematics seemed to offer.

Consider, for example, the attempts to include gravity in the unification mechanism of interactions: string theory and supersymmetry were almost exclusively mathematically motivated, but mathematical motivation was also dominant in twistor theory and loop gravity.

This went so far that theoretical physics even threatened to decouple itself from physics in the sense of a *description of nature* by completely losing itself in a purely mathematical paradise.

From the perspective we have arrived at in this book, i.e. from a metric-dynamic perspective, this is a completely wrong approach – for two reasons:

The first reason is that the power of mathematics is seductively great, perhaps even so great that it can be possible to "unify" heterogeneous formal structures, which actually have *nothing physical* to do with one another, into a higher-level formal structure using specific mathematical procedures.[86]

Let us assume, for example, that there is a description of reality for which the following applies:

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[86] This follows from the definitions of mathematics and reality (at the beginning of 14.2.3) and the immediately adjacent elucidations.

1. The description breaks down into several parts, which together encompass the entire reality.
2. All partial descriptions are good approximations, but they are false in the sense that they miss the basic causal structures of reality.
3. Some of these partial descriptions contradict each other.

Then it cannot be ruled out that mathematical procedures can be found through which the contradictions can be eliminated, and that a mathematical structure exists that contains or encompasses the structures of all partial descriptions. Then most theoretical physicists of today would celebrate this comprehensive structure as *theory of everything*, as the *perfection of physics* – even though, according to our assumption, it completely misses reality.

Unfortunately, this is not just a thought experiment, but rather describes – again from a metric-dynamic perspective – exactly the conditions of the last decades.

Fortunately, it has turned out that mathematics is not powerful enough after all – or rather, that it has defended itself against this abuse and has (so far) not provided any procedures that would have allowed the unification of incorrect and contradictory partial descriptions.

The second, even more important reason is that, when theories are stuck in dead ends due to false ontological assumptions, mathematics often offers *no chance at all* of finding a way out of this dilemma.

The best example of this is the quantum mechanical measurement paradox. Let's consider it again in the form of the double slit experiment:

In the explanation I presented in Section 7.1, the crucial fact is that the electron wave that runs through the double slit and then arrives at the detector plate, ***is not identical*** with the electron particle detected afterwards.

If one does not recognize this fact, but rather assumes that the quantum mechanical description *before* and *after* the measurement refers to ***the same object***, then there is no chance at all of justifying this transition – the "collapse of the wave function" – in a mathematical way: the completely wrong assumption does not allow for a meaningful explanation.

Then purely formally there is nothing more to say than that the square of the amplitude of the wave determines the probability of the particle appearing. Any further attempt at explanation must fail, any attempt to describe and understand this transition *as a process* must be nonsensical if this process is understood as change between two states of the same object: ***of course a process that does not exist at all cannot be described in any meaningful way***.

Could aberrations of this kind be avoided? In any case, a necessary condition for this would be the insight that reality and mathematics are *not the same*, and ***never*** are – and that therefore the usefulness of a mathematical structure in a certain area of reality in no way justifies the assumption that the reality ***is*** this mathematical structure.

Probably the best-known case in the history of physics in which such an identification was performed is the special theory of relativity, in which the values of space and time measurements are combined into a four-dimensional mathematical structure. This structure is indispensable for carrying out physical calculations. Nevertheless, also in this case it cannot be concluded that reality ***is*** this structure. But that's exactly what the physicists of that time did. (I remind you again of the quote from Hermann Minkowski: *From now on, space for itself and time for itself should sink completely into shadows*...)

However, this identification is wrong: space and time are linked only mathematically; ontologically they remain (of course) separate – *real* space remains three-dimensional and does not, along with time, transform into four-dimensional space-time. (You can check this at any time by simply trying to walk along the time coordinate.)

The problem with such an identification – not just here, but in general – is the following:

If nature is *identified* with a formalism, then it no longer makes sense to ask why it *obeys* this formalism. Then it can no longer *ontologically*, but only *formally* be investigated, why something is the case – why, for example, time passes more slowly in moving systems; However, as we have shown, this has serious consequences: under this condition, the *actual* reason for the time structure of reality, which makes it possible to recognize the fundamental layer of reality, remains hidden.

In the transition to general relativity, the identification of reality and the four-dimensional mathematical structure of space and time measurements has the consequence that the fundamental causal mechanism of gravity becomes inaccessible: from the purely formal generalization of justified coordinate systems, there is no path to the central concept of the metric-dynamic gravity, the *metric flow.*

I don't want to proceed systematically here, but just give two more examples.

In order to describe a quantum mechanical measurement process, we need the representation in Hilbert space. Let's now imagine that we could "zoom in" further and further into what is happening in the double-slit experiment: would the three-dimensional space, in which we are and in which we have set up the experiment, at some point *metamorphose* into the Hilbert space? Hardly likely. Here, too, this space is a useful – and in some cases even necessary – aid for calculations, but here too it would be downright absurd to assume that the area of reality in which the process takes place ***is*** a Hilbert space. But, as noted above, also in this case it is again the identification of reality and mathematical structure that prevents the correct interpretation of the experiment.

As a final example, we choose that distant object of contemporary theoretical physicists' longing: the (currently unknown) mathematical structure of superstring theory. The basic elements of this structure – broken symmetries, strings, supersymmetry, multidimensionality – owe their existence almost exclusively to the effort to make the infinities manageable that arise in the desired unification of physics. From our point of view, however, with each of these purely mathematically motivated steps the probability of getting closer to the structure of reality becomes smaller. This suspicion is supported by the fact that so far there is no experimental validation of superstring theory at all, so that its proponents now mainly rely on the conviction that the structural richness of the theory is so overwhelming – even in its present preliminary stage – that it simply *cannot* be wrong. But the question arises whether this richness is not just based on all the special mathematical features from which the theory is built, and not on its relationship to reality; mathematical greatness *alone* is certainly not an indication of the correctness of a *physical* theory.

All of these examples indicate that limiting ourselves to mathematics is not the right way to solve physics problems. If there is a lack of interpretation of what occurs in a physical process, then mathematics is often misleading: in the scenarios just outlined – which are fundamental to physics – the correct explanation is *obscured* by the identification of reality and mathematical structure, and there are even cases where the limitation to mathematical methods completely excludes a solution to the problem (as in the quantum mechanical measurement process).

How did mathematics come to be so dominant and interpretation to play such a subordinate role?

Undoubtedly, this development begins with Newton's theory of gravity. On the one hand, it is ontologically impossible and therefore uninterpretable: there cannot be any interaction between masses across Newtonian empty space – Newton himself tried several times in vain to ground his theory in an ontological way – but, on the other hand, it is incredibly successful. Other, ontologically motivated theories, such as Descartes' ether vortex theory, were completely unsuccessful.

Something similar happened later with Maxwell's theory of electromagnetism: Maxwell also tried for many years to explain his equations based on the dynamics of the ether in a mechanical and intuitive way and failed.

Ontology never recovered from these setbacks. This marked the path to the dominance of mathematics.

The failure of the interpretations of relativistic and quantum mechanical facts then led to the almost complete disappearance of interpretation in physics.

In the case of special relativity, the explanation remains purely formal, and we seem to be forced to abandon our *a priori* understanding of space-time.

In the case of quantum theory, there is no longer any interpretation at all (here is more to that), but at best explanations *why* there is no interpretation; But what predominates is the retreat into pragmatism and formal schemes.

The arguments presented in this book, on the other hand, lead to a completely different understanding of these two theories:

It was shown (in the Status Report, in Section 3.1 and in Chapter 6) that the special theory of relativity – *if interpreted correctly* – does not at all *abolish* our *a priori* idea of space-time, but rather, on the contrary, it *follows* from this idea.

This interpretation is then an essential element in the new basis of the description of reality presented here, in which so many previously unsolved problems could be cleared up.

The same applies to the new interpretation of quantum mechanics, which provides an explanation of the formalism (see Section 7.6) through which quantum mechanics transforms from a theory that seems completely inaccessible to our thinking into a theory that can be understood and explained.

In this interpretation, it even proves to be a *confirmation* of the metric-dynamic hypothesis that reality is a web of metric changes in space and time, for the following reason:

The immediate consequence of this hypothesis is the existence of metric waves, which form the basis of all material structures, and this is precisely the premise necessary for understanding the quantum mechanical formalism.

Here again it is clear: the path to problem solving does not begin with mathematics, but with trying to understand what is happening.

If this attempt is successful, immediately further insights emerge and physical research is directed towards new goals.

However, at my theory of gravity I arrived in a completely different way: it wasn't the attempt to understand gravity that set me on the path, but rather the attempt to describe how reality comes into existence.

If I had been asked back then whether I wanted to work on gravity, I would certainly have said no.

But after I discovered the fundamental equations (0) and (1), it simply didn't matter whether I *wanted* to, because Newton's equation suddenly appeared as if by itself, without me asking for it.

The path to the perihelion precession wasn't much longer: it wasn't directly in front of me, but only a few lines away. And when the result actually agreed with that of general relativity, it seemed almost like a miracle to me.

Back to our topic:

Equations (0) and (1) follow from considerations based on the metaphysical concepts *substance* and *activity*. So when creating my theory of gravity, the first step was not *interpretation*, but rather the *inclusion of* ***metaphysics***.

It is precisely this step, which results from the analysis of the difference between reality and description, that represents the starting point for all further arguments and explanations, and that constitutes the fundamental, the *real* difference to the usual physical description system and the methods used in this system.

Only through the combination of physics and metaphysics does it become possible to recognize the causal metric foundation of the description of reality and, starting from this basis, to clarify all the physical questions that have been analyzed here.

In the philosophical part of my deliberations, the inclusion of metaphysics is even more central:

To substantiate causality it is necessary to go back to the *origin of reality*, to establish free will requires insight into the difference between reality and description, and to substantiate the occurrence of qualia and the impossibility of robot consciousness, the use of metaphysical arguments is even more extensive.

I hope that I have succeeded in showing that this "minimal metaphysics" – in contrast to traditional metaphysics – is rationally founded and completely reasonable.

However, I am confident about this:

Who could doubt that reality is ***active***, as opposed to a description of reality that is ***not active?***

This Final Report has become a two-fold plea:

Firstly, to give greater importance to interpretation in physics – i.e. to the attempt to understand *what is really happening and why it is happening* – and not to rely solely on mathematics.

Mathematics, of course, remains the only possibility of *accurately* describing material reality, but in order to find solutions to problems and to create new theories, and even more so to determine the goals of physical research, it requires guidance through interpretation.

Secondly, for reintegrating metaphysics into natural science and philosophy, albeit in the reduced form, purified of all projections, which has been presented here as *minimal metaphysics* and which has proved so extremely fruitful in clarifying numerous physical and philosophical questions that have remained unanswered for so long.

Heinz Heinzmann

Vienna, September 2022

Postscripta

The conclusion of my book will once again be dedicated to the central topic: the structure of the entire description system and the close connection between the theories it contains.

This time, however, I will not proceed systematically, but rather concentrate on the details and methods of some explanations, which in retrospect seem to me to be presented insufficiently and, above all, not clearly enough, and try to show how they act together for the merger into a system, i.e. to ensure that reality can be understood as a unity.

I start with the explanation of special relativity – not only because it was my first step on the way to the new view of reality, but also because I consider it to be the best introduction to my description system.

The explanation presupposes the insight – which comes from Einstein – that time does not, as Newton thought, "flow uniformly in and of itself and of its own nature, without reference to anything external".

However, this immediately leads to the realization – which goes beyond Einstein and away from him – that the times that apply in different locations must first be *generated* through causal processes. This also means that the *relationships* between these local times depend on the speed of these processes, which in turn means that, due to the necessary unambiguity of the time system, *there can only be one single speed*. All other speeds must be derived from it.

With these few statements we have already moved very far away from current physics. It is therefore imperative to look closely at each of these statements and realize its necessity. Only then can the conclusion "There is only one speed" take its rightful place at the base of reality. That's why I want to pause here for a moment and repeat the train of thought:

If time does not flow "in and of itself and of its own nature", then any local passage of time, as well as the relationships between the local times, must be *caused* by something. It is evident that this causation must be attributed to the causal processes by which the objects of reality are connected to one another.

The next step is to understand that the time relations created in this way depend on the state of motion of the objects. This requires the following consideration:

We look at two objects. At first they both are at rest. But if they now begin to move along their connecting line in the same direction at the same speed, then the relation between the times that apply to them changes – simply because *each* of the causal, time-generating processes that begin at the object in front and end at the rear one, now arrives at this rear object *earlier* than the same process in the case of the objects at rest, because now the rear object is running *against* this process.

But this means nothing other than that – with respect to the rear object – *the time at which the process was* ***sent off*** *has now,* compared to before, *shifted into the past.*

Obviously, however, the extent of this shift depends on the speed of the process: the smaller the speed, the greater the shift.

However, the relationship between the times that apply to the two objects must be unambiguous, and this means that there can only be a single speed and that all other speeds must therefore be derived from this speed.

This fundamental speed we call c.

Let's continue the train of thought. To the next statements the same applies as to the previous ones: they lead even further away from known physics, and that is why I invite every reader not to read any further before she has taken up a clear and unambiguous position to the content of these statements.

If there is only one speed from which all other speeds must be generated, then one is faced with the question of how this generation process takes place. The answer is: by superimposing waves traveling in opposite directions with speed c.

In this way, any speed can easily be generated.

We did this in Chapter 6. It turns out that the speeds generated by wave superpositions conform to the temporal relationships established by the speed c itself.

In this way, we reconstructed the special-relativistic spatio-temporal structure, without any physics, based only on logical and metric considerations. That makes this approach a real new beginning in the description of nature.

What does actually oscillate here? Space itself, i.e. the *metric*. What in Einstein's special theory of relativity appears as a mere (Cartesian) coordinate system, already here becomes a *metric*, and since this metric is the necessary prerequisite for all velocities smaller than c, it also becomes the prerequisite for existence.

So it is even clear already at this point in our considerations that (metric) space is the basis of everything that exists and that there are only waves. (See also the comments in Section 3.2)

However, the assumption of opposing waves with speed c seems strange at first, because it is difficult to see how any idea of reality could arise from this.[87]

Just a first hint suggests that there is a connection to the usual description of material objects: As shown in Section 6.5 on page 111, the existence of matter waves follows directly from this assumption.

However, at the moment we will not pursue this connection any further, instead we will show how the special relativity established in this way is related to our description of gravity.

Gravity was presented here (like everything else) as a purely metric phenomenon: mass is understood as *metric compression*.

When a region of space is metrically compressed, this causes a metric acceleration: The metric continuum which lies outside this region is accelerated towards the compressed region.

So each metric element moves at an accelerated rate along a flow line that begins at a source (with v = 0) and either leads to a condensed region or ends at a point that is also a source. (See e.g. sketch S10.) The metric continuum is constructed from such flow lines.

The acceleration that a metric element experiences corresponds to Newton's acceleration – with the difference that the gravitational effect is not present instantaneously, but propagates with the speed c.

However, this acceleration can only approximately be equated to the acceleration experienced by the masses – for an exact calculation it is necessary to determine the local space and time differentials from the respective speed of the metric elements, according to the rules derived from special relativity. (See formulas (21), (22) and (23) on pages 49 and 50.)

In the case that the metric flow is directed exactly towards the center of mass of a system, the results of this theory of gravity agree completely with those of the general theory of relativity.

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[87] The associated mental image must of course be 3-dimensional: The construction of the special relativistic space-time structure carried out in Chapter 6 is based on the assumption that the fundamental level of the universe consists of 3-dimensional standing waves (– the length of which is the Planck Length, a fact which we will return to below).

Obviously, however, this condition is precisely realized only if the system consists of nothing but a single non-rotating mass – i.e. actually never.

But in solar systems and in the gravitational field of planets, due to the dominant central mass, it is fulfilled with such close approximation that there is sufficient agreement between the two theories for almost all gravitational phenomena.

However, in galaxies they generally produce very different results.

The interior metric is also different, even in the case of a single mass, where there is complete identity with respect to the exterior metric. (As shown in 4.7 on pages 55 and 56, this difference can be used for an experiment that can be carried out on Earth and can decide between the two theories.)

So what is the connection between special relativity (SR) and metric-dynamic gravity (MDG)?

First of all, here is a visual image:

The straight lines, along which opposing waves travel at the speed of light and form standing waves in my version of SR, become *curved* due to the inclusion of gravity, and the standing waves begin to *flow* – which means: the *straight lines* of SR turn into the *flow lines* of MDG. (We'll come to the waves that run along these lines shortly afterwards.)

The changes in lengths and times due to relative movements, which form the content of SR, are the basis for the calculations of the space and time differentials of MDG. Using the laws of SR, the metric that is changed by gravity can be determined from the velocities of the metric elements.

The generalization of coordinate systems carried out by Einstein in the transition from SR to GR – in SR they are Cartesian, in GR arbitrary (4-dimensional) coordinate systems – also applies in MDG, but the values of the coordinate differentials change in MDG compared to GR, and in addition not all coordinate systems are permitted but only those that result from the possible velocities of the metric elements (from which follows a massive restriction of possible gravitational scenarios in comparison with GR).

Now to the waves with light-speed c, which are required in my version of SR to produce velocities smaller than c.

Though they play no role for gravity itself,[88] they must be present because – as described above – the flow lines of gravity are nothing other than the straight lines of the Cartesian coordinate system of SR that are bent by gravity.

In SR, the wavelengths of the waves traveling with speed c are arbitrary, only their alteration by a multiplicative factor is important.

But now the following turns out (see Chapter 9):

If we choose the Planck length as the length of the waves traveling along the flow lines at the speed of light, then the quantum mechanical atom model can be reconstructed using simplest mathematical means.

It is clear that, due to this result, the initially strange assumption of waves traveling in opposite directions at the speed of light, which is required in SR, is confirmed in a way that could hardly be stronger.

With this, a connection between special relativity, gravity and quantum theory comes into view that previously was not visible.

In addition, the wave-based structure of the quantum mechanical atom model reveals a *constructive connection* between the different wavelengths present in the atom, which lets an alternative view of the evolution of the universe appear plausible – without Big Bang and without dark energy, which is in some respects preferable to the Standard Model (see Chapter 10).

The ultimate reason for all these connections lies in the fact that gravity and electromagnetism have a common basis: both interactions arise from the fundamental equation (0), which describes the creation of reality; From this equation follows that *everything that exists and that happens* can be traced back to two types of metric changes: changes in length and changes in angle.

And from this follows the existence of metric waves (see Chapter 3) – precisely the waves that are required for the construction of SR (Chapter 6), the explanation of quantum theory (Chapter 7) and the construction of material structures (Chapter 9), and this ultimately leads to the idea of the

[88] However, gravitation can also be described based on the frequencies of these waves – alternatively to representing it using the metric flow. But in this book I didn't go into that.

universe as a structure that organizes itself in the form of standing waves on several orders of magnitude and whose basis are standing waves of Planck length.[89]

What motivated me to briefly summarize some of the connections in my description system also applies to the relationship between metric-dynamic physics and standard physics: here too I have missed some clarity. Therefore, an (equally short) sketch of the confrontation of so-called "classical" physics with quantum mechanics and the resulting current status of physics, as it appears from a metric-dynamic point of view, should now follow.

At the end of the 19th century, physics seemed to be nearing completion. Most of the scenarios that physicists had in mind could be described satisfactorily, and only a few remained to be clarified, such as black body radiation or the photoelectric effect.

However, it was precisely the success in describing these scenarios that led to the collapse of the previously valid division of reality into *continuous* and *discontinuous* phenomena, i.e. into *waves* and *particles*.

In this way, concepts entered physics that were in stark contrast to the previous view of reality: *wave-particle dualism* and *uncertainty.*

The handling of these concepts, which has become established in standard physics and solidified into "orthodoxy", is well known and can be characterized in a few words:

Assumption of a fundamental quantization of reality and of a "double nature" of everything that exists, which – depending on the situation – can appear as wave or as particle.

In experiments in which a transition between these two manifestations takes place – the best known of which is the double slit experiment – the only way out was to resort to an interpretation of the square of the wave amplitude as probability (in the continuous case, probability density) of the

[89] However, standing waves alone are too simple to get an idea of a reality that is made up of waves. Chladni figures – or their 3-dimensional, electronically generated analogues – are better suited for this. They give an idea of the fantastic diversity and complexity that metric self-organization can develop into. (For example, there is a close relationship between electron orbitals and Chladni figures.)

observed events, or – to express it in its full absurdity: to the interpretation of the amplitude as root of the event probability.

What's absurd about that?

Very simple: after the double slit, *interference* occurs. This means that here two phenomena *influence* each other. And since it is not just mathematics ***and nothing else***, but mathematics ***that describes something***, these two phenomena must be granted ***existence***, because only under this condition is it possible for them to influence each other.

And under this assumption it is undoubtedly absurd to regard the wave amplitude as root of a probability and to call this an ***interpretation***: roots of probabilities are purely formal quantities, to which cannot in any way be attributed existence. So it is not an interpretation, but rather ***the total withdrawal from interpretation***, or, to expose it once again in its absurd and unfortunately also tragic nature: ***the complete and final loss of reality***.

In addition to this orthodox "interpretation", there are several other attempts to clarify what happens in quantum mechanical measuring processes. However, I consider it superfluous to present them, since none of these attempts provides answers to the crucial questions, which are:

1. ***Why***, 2. ***How***, 3. ***When exactly***

does the transition from wave to particle take place? And also:

4. ***How can a wave that has <u>proven</u> its existence by interference disappear after the particle is measured, no matter how extended it was?***

And what's actually even worse than the lack of answers is the fact that the creators and advocates of each variant don't even notice this lack. One must conclude that they have actually completely lost their connection to reality and that – as a result of this loss – they have no longer any competence to explain what happens in reality in general.

A science that no longer strives for explanations and which, moreover, is completely unaware of this fundamental deficiency, offers little incentive for those seeking insights. This also marks the transformation of (theoretical) physics: from a discipline that was hardly conceivable without the connection to philosophical questions, to a mathematical artistry for which reality only plays a very subordinate or even irritating role.

The inevitable consequence of this fatal development is the almost complete failure of all attempts to further develop the theoretical foundations of physics – at least when measured against physically usable results. Due to the loss of interpretation and at the same time of reality, physics suffers from the lack of guidance and becomes lost in epistemological dead ends, in other words: it never finds its way back to reality.

Now for my interpretation. *What really happens during quantum mechanical measurement processes?*

First a little foreplay:

I start from the assumption: *There are only waves*.

Anyone who is even a little familiar with the history of interpretation of the reduction of the wave function will now immediately object: "What nonsense. Already Schrödinger tried to get by with waves alone, and even back then it didn't work!"

Yes, that is correct. But the reasons for Schrödinger's failure represent an ideal introduction to my explanation. As follows:

Schrödinger's attempt to explain the processes in quantum mechanical scenarios exclusively through waves fails in two ways:

Firstly, he was not able to construct wave groups that remain tightly localized – which he considered to be absolutely necessary in order to model *particles*, and secondly, he failed to describe the photoelectric effect.

This is so revealing because in both cases the reason for his failure is that a necessary prerequisite for a description by waves was not met:

In the first case, the reason is that Schrödinger did not manage to sufficiently break away from the particle concept; in the second case, the reason is that he tried to represent the photo-effect *using the formalisms of classical physics*, and that is actually impossible (– unless you take a dualistic position, as Einstein did, and that is then the first step in the aforementioned descent of theoretical physics).

The metric-dynamic understanding of reality reveals the background to this situation. Here is a brief overview (I don't make any references – basically the whole book is about it):

The central hypothesis is as follows:

No matter how successful classical physics may be with all of its conceptualizations and mathematical methods, *it still fundamentally misses what reality actually is*.

What has been established since Galileo's rolling balls, swinging pendulums and falling stones through the interaction of experiment and theory, is excellently suited to describing the facts that can be experienced in the medium-sized world that surrounds us, but ***the totality of these experiences <u>necessarily</u> misses the causal structure of reality***:

Experience comes exclusively from observation of individual cases, and *the connection between cause and effect cannot be found in individual cases;* The general, the law that we believe to recognize in individual cases and whose existence we cannot doubt, ***cannot be found in the realm of experience***. (See Chapter 11)

That from which the law of reality comes, in other words: what reality *actually is*, must therefore be of a different kind.

To put it in contemporary terms:

The realm of everyday experience is merely the graphic user interface of reality.

From this perspective, the encounter between classical physics and quantum mechanics must be understood as follows:

As physics succeeded in penetrating smaller and smaller areas of nature as a result of improvements in the means of observation, the *fundamental level of reality* – precisely what reality *actually is* – gradually came into the focus of physicists. Apparently it was *a world of waves*. But there were two problems: The first was the question of *what* is actually vibrating (see above), and the second was the question of which relationship there is between this newly discovered area of reality and previous (classical) physics.

Physicists have completely failed to answer these two questions. The interpretation of the amplitude we have already criticized, and the connection between the old classical and the new quantum mechanical reality is little more than a mere juxtaposition with a blurred boundary.

The metric-dynamic answers are as follows:

1. *That which vibrates is* **space itself** – in two ways: either in the *metric density of the length* (which leads to gravitation) or in the *metric density of the angle* (which leads to electromagnetism and Atomic structure).

2. *The newly discovered realm of reality reveals what reality actually is:*

A purely metric world.

This means:

In order to describe ***and understand*** processes in which the quantum mechanical phenomena play a role, ***the known (classical) physics must first be completely dispensed with***.

In actual fact, it even means that the entire physics has to be rebuilt on a metric basis – exactly as I did in this book in the photo effect, the Compton effect and then also in the re-foundation of special relativity and in the derivation of my theory of gravity, and finally also for electromagnetism and the Atomic structure, where at least I carried out some initial steps.

Only *after* this reconstruction, the well-known theories that are so successful in standard situations are needed, and then there are two possibilities: either the old and the new theories are identical and differ only with respect to their substantiation and derivation – as in the case of the special theory of relativity, or the old theories turn out to be approximations of the new ones – as in the case of gravitation.

After these general considerations, we now turn to two of the scenarios mentioned above, the photo effect and the double slit experiment.

In fact, when describing the photoelectric effect (and the Compton effect as well), *I didn't use any physics at all* (except at the very end), but simply relied on what waves do, that is: *superimposing each other*. In this way that, which is impossible with the means of classical physics – so that Schrödinger had to fail – appears almost by itself: *the desired result*, i.e. exactly the result that Einstein only achieved by assuming that light consists of particles (energy quanta).

Now, in a few words, the explanation of what happens in the double slit experiment:[90]

An electron (*a **traveling wave** of metric angular density*) is released from an electron shell (i.e. *from a **standing wave** of metric angular density*) and passes through a double slit. The wave interferes with itself and then hits a detector plate (*an enormous number of standing waves of the same kind*) and there, at one of these standing waves that is *close enough* to the transition to the next higher state (*the state with one more node surface*), it induces exactly this transition by merging with the local wave. This transition appears *as jump* (*as is **always** the case with standing waves*) and is interpreted as the appearance of an electron. Of course, the rest of the traveling wave ***does not***

[90] The main part of the explanation can be found in Section 7.1. However, some important additions follow in Section 9.11: only there the means are available through which spin and angular momentum can be integrated into the concept of standing electron waves.

disappear, but rather hits other standing waves, where, however, it does not trigger a transition but only increases the probability of future transitions by shifting the state of the standing wave closer to that transition.

Here you can clearly see why Schrödinger had to fail: it is not possible – and in fact quite unnecessary – to demand a "localization" of the traveling electron wave: the transition from "particle" to wave is simply the transition from (a sub-area of) the standing wave to a running wave. If the electron is a traveling wave that can be extended to any arbitrary size, then the term "particle" loses its meaning.

Just as I did in the Final Report, I want to finally emphasize *the fact that represents the real,* ***the irremediable obstacle****, which makes it impossible for all other interpretations of the quantum mechanical measurement process to explain what is happening there:*

The object that is detected – the electron particle – is <u>not identical</u> with the electron wave that hits the detector plate after the double slit.

According to my explanation, *only a tiny part of the traveling wave* hits the standing wave, where it merges with it and thereby triggers a transition, while the rest of the wave continues running and hits other standing waves.

However, all other interpretations try to describe the transition from wave to particle as a <u>transition between two states of the same object</u>, and that means: they try to describe a process that does not exist as such and therefore invariably end in gross nonsense.

What began as an attempt to find answers to individual physics questions has developed into a new physics that differs from current physics not only in terms of the theories themselves, but also in terms of the associated justifications and explanations, and ultimately even in the type of access to reality:

Starting point for describing nature is no longer the quantification and generalization of observable facts, but rather the mental exploration of the prerequisites of existence. This leads to the insight that the metric of space-time is the only possible basis for describing and explaining reality. Only under this condition causality and thus the existence of natural laws can be justified, and only in this way the unity of nature is preserved in the description.

I have occasionally asked myself how this could have happened, since it does not correspond in the least to my original purpose.

Looking back, however, the answer seems simple to me: every single one of my explanations of physical questions leads beyond the realm of the usual interpretations and associated conceptualizations. At first these various explanations appear separate, each on its own, but over time it became increasingly clear that they merge into a new, unified description system built on a purely metric basis.

The distance to current physics is so great that communication may be difficult, if not impossible.

As long as I was busy pursuing my objectives, I paid little attention to what was happening in standard physics. But when, towards the end of my project, I gradually turned my attention back to the scientific-philosophical landscape, it seemed to me as if there was just more – *much more* – of the same.

Again and again it's about "deviations that point to a new physics beyond the standard model of particle physics" or about "observations that seem to suggest corrections to the cosmological standard model". There is talk of "new particles" and "forces", or of "other universes" and "additional dimensions", but never anything really new comes into view.

Nobody sees the possibility that there might be something fundamentally wrong with these "standard models" and their further development – that the standard model of particle physics only provides a classification of what exists, but apparently does not contribute anything to the questions of its creation and the size of the many free parameters, and that therefore the whole group theory approach is a dead end that leads nowhere, a straitjacket that restricts thinking and strangles creativity, or that the cosmological standard model is simply wrong and has *therefore* lost its way so that it ends up in dubious hypotheses about the "multiverse", "Dark Energy", "Dark Matter" etc.

How long can such a condition last? I have no idea. Several decades have now passed without the advanced theories of physics having contributed anything verifiable to the description of reality. Nevertheless, most physicists seem to be convinced that they are "on the right path" to which there is no alternative ("The only game in town").

I even doubt that such a massive change and renewal as I propose here could be achieved within one and the same culture. I myself perceive the transition from common beliefs and habits of thought to my description system as a dramatic change from one culture to another, and this applies not only to the physical, but even more to the philosophical part of my explanations. I consider what is currently being said about the questions of free will or robot consciousness to be completely inadequate, and that is a fundamental failure: a failure to determine the essence of human being, that is: to answer the question: *What is man?,* which forms the basis of every culture.

Nevertheless: Now, after finishing this book, I have the desire to find out whether and to what extent I am right, and the opportunity to decide on this alone is unfortunately limited. Over time, you move more and more within your own context of reasoning, and despite intensive efforts, it is clearly more difficult to search for arguments that speak against your own position than for those that support it.

The appropriate start to a review would certainly be to carry out the gravitation experiment (see pages 55 and 56), the outcome of which would decide between the general theory of relativity and my theory of gravity.

Heinz Heinzmann

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