Against Dark Matter –
A New Theory of Gravitation

Contents

Abstract

In the following, I shall present a new view of gravitation that offers the possibility to understand the gravitational effects currently attributed to dark matter as caused by the known luminous matter.

On the method:

Ontological considerations lead to an equation that can be understood as description of the process that generates reality. On the basis of an additional metric assumption, a model of gravitation can be derived from this equation which, in the case of a dominant central mass – e.g. near planets or in solar systems – leads to the same results as Newton's – or, more precisely: as Einstein's model, which will be demonstrated using some of the well-known tests of the general theory of relativity. In the general case, however, the new model deviates from general relativity, especially in the case of systems with very large total torque; e.g. for galaxies a significantly higher rotation speed is to be expected.[1]

There is also a proposal for an experiment – designed like the Mößbauer experiment by Robert Pound and Glen Rebka – which can decide between general relativity and my theory, see pp. 21/22.

0. Preliminary Remarks

The theory that I present here lies far beyond current physical habits and expectations in terms of content and form. Therefore I will start with some introductory remarks.

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

The essence of my theory is best captured by the following comparison:

In Newton's theory, mass affects mass. In the GR, mass acts on space-time. In the MD, *metric affects metric:* metric compression causes metric acceleration; mass is *defined* as metric compression.

This means: *the metric itself* is moving, and it is only through this motion that the masses are accelerated too.

So, *metric flow* is the central concept of MD: gravitation is understood as acceleration of the metric flow caused by metric compression of length, i.e. shortening of the length unit.

In the spherically symmetric case of a single non-rotating mass (in the case of the Schwarzschild solution of the GR), MD and GR actually agree completely. Surprisingly, this agreement only exists in this case, and here only with regard to the exterior solution.

If the system under consideration contains several masses, the two theories differ, and to a much greater extent the differences in their results depend on the magnitude of the total torque of the system.

In the gravitational field of planets and in solar systems, however – 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 with galaxies: here, most of the total mass is off-centre, and the total torque is enormous in almost all cases.

Under these conditions, from MD a significantly higher rotation speed of the outer regions of galaxies follows than from GR. So there is the possibility that dark matter can be omitted for the explanation of the galaxy rotation.

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1 If you are only interested in the formal part, I suggest starting with Section 4 on gravitation. To me, however, it seemed essential to describe the considerations that led me there.

Thus the difference between MD and GR is not just a correction in the area of sufficiently great distance. Rather it is based on a fundamentally diverse conception of space: In MD, space itself – understood as metric space – is set in motion, and this is precisely the reason for the much higher rotation speeds of galaxies. Seen from GR, this dynamic view of space is unattainable.

So much for the difference between GR and MD.

The context of justification for MD is even further away from current physical thought patterns: It follows from an equation that results from considerations on the emergence of reality.

Initially, the derivation of this equation was done without any particular intention; it was by no means planned as starting point for a theory of gravitation. However, Newton's gravity follows almost immediately from it – after only one single step – and the derivation of the perihelion precession also requires only a few lines.

And, finally, the new view of gravity emerging in this way also leads to a higher rotation speed of galaxies – and that too without any intention but simply by itself.

I think this provides a clear motivation for including this new understanding of gravity in the assessment of the current problems related to galaxy rotation.

1. The Process that Generates Reality

Our first goal is to examine whether statements are possible about that from which reality arises. However, the purpose of these statements will not lie in themselves (as has been the case in metaphysics up to now), rather they should be judged according to the extent to which they are suitable as basis for the derivation and explanation of the physical description of reality.

If one aims to *substantiate* existence, one cannot start with something that already exists. Therefore, that which produces reality must – in an ontological sense – lie *before* all existence. So it is not an object. From this follows that we cannot think it as that what it "is", since our thinking cannot leave the network of relationships between objects.

But even if we cannot think it as *it itself*, there is still the possibility to say something *about it:*

(1) Since we assume that it produces reality, we must attribute *activity* to it. (I will therefore refer to it as AGENT.)

(2) Without comparison there is no distinction. Therefore distinction presupposes *existence*. Thus, *in itself,* AGENT must be *indistinguishable*.

(3) That AGENT is active means that it abolishes its indistinctiveness: AGENT is *That-Which-Changes*. By changing itself, AGENT creates differences and thus rises into existence.

Our second goal is to bring these statements about AGENT into a mathematical form. To this end we now shift from the *origin of reality* to the *origin of the description of reality* – or, to put it philosophically: we shift from what AGENT is *in itself* to what it is *for us*.

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

What is AGENT? *The logical and ontological presupposition of reality.*

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

Space and time.

This means:

For us, AGENT **is** *space and time*.

According to (1) and (3), AGENT creates reality by changing itself. So we begin building our description of reality with the description of a change.

The first question is: *What* is changing?

That, what AGENT is *for us:* space and time. (Since we are still *before* all existence, it *can* only be space or time.)

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

According to (2), AGENT is in itself indistinguishable. So there is *no structure and no memory.*

This means that each change in time can only refer to the respective previous moment, and each change in space can only refer to an immediately adjacent position.

Thus, changes must be represented as differential quotients.

Let us start with a change of space. How can space be altered in a description? Only by changing its measure of length or angle.[2]

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

Let r be a spatial coordinate. Then

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

– 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 sufficient 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 AGENT, 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.

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 on AGENT, 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.

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2 As it turns out, changes in the measure of length lead to gravitation, changes in the measure of angle lead to electromagnetism. Since we are only concerned here with the derivation of gravitation, we restrict ourselves to changes in the length measure.

However, 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

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

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

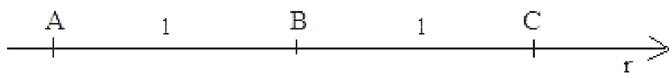
$$\zeta = \frac{v}{c}$$

c is the constant, v is the variable.[3] Thus equation (0) turns into

$$\frac{d\sigma}{dr} = \pm \frac{d\frac{v}{c}}{d(ct)} \qquad (0')$$

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

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:

3 Setting the metric density of time as v/c is motivated by the fact that the velocity v then contains the complete metric information, i.e. the information on how lengths and times change as a function of v. This leads to the relativistic structure of reality.

(S2)

The *distances* have remained identical – they are still 1, but the length of the measure (the measuring unit) has increased between A and B, and decreased between B and C.

This means: *the metric density* σ between B and C is greater 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 further below.)

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 undetermined. We let us guide here by the idea that B is accelerated back to the midpoint of AC.[4] This means that in (1) the negative sign has to be chosen, i.e

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

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

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

By 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/σ is omitted; σ *has no memory.* There is no absolute metric density, there are only density relations.[5]

This completes this First Section. The aim was to bring ontological conclusions into a mathematical form suitable as basis for physics. The statement we have arrived at along this way is as follows:

Reality is a differential web of interdependent metric changes in space and time. 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 statement is based solely on the analysis of the origin of existence. In the next section, we will take a first step to make it more concrete.

4 The other case arises with antimatter. (See my book *The Structure of Reality*, p 82.)

5 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.

2. Waves

The dependency of σ and v, expressed by (1'), entails an inverse dependency. In the sketch (S3), v decreases in flow direction: therefore, in the length element at P, the inflow is greater than the outflow.

(S3)

As can be seen from (S3), it follows

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

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

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

Also in this case, the factor 1/ρ occurs because the increase in density over time depends on the initial density, which relates to an absolute scale. In the case of σ, there is no absolute scale, only relative changes; so this factor must be omitted.

From (1') $\left[\frac{d\sigma}{dr} = -\frac{1}{c^2}\frac{dv}{dt}\right]$ and (1a) $\left[\frac{dv}{dr} = -\frac{d\sigma}{dt}\right]$ follows the wave equation

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

– and, because of the symmetry of v and σ in (1') and (1a), also the wave equation

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

Additionally, because of v/c = ζ, from (2) follows

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

So we get waves in v whose velocity is c, and two types of metric waves – waves in σ, the metric density of the length, and waves in ζ, the metric density of the time – also with velocity c. (As the name already indicates, c will later be identified with the speed of light.)

Since Equation (1a) is valid for a length element that is moving with the flow, ***all these waves are waves in the metric flow***.[6]

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6 If σ in (1) is taken not as metric density of the *length* but as metric density of the *angle*, one obtains further waves: waves of the metric density of the angle and waves in w, a velocity orthogonal to the direction of the flow v. (*The Structure of Reality*, p 23 ff.)

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

3. 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 was sent off 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 c.

(The simplest form of such a derivation is to base it on superpositions of opposing waves. The speed of the superposition then depends on the frequencies of those waves. I have done this in my book *The Structure of Reality*, starting from page 97. In this way, the special theory of relativity can be derived without presupposing the principle of relativity or the constancy of the speed of light for every uniformly moving observer.)

So in that sense there is only light speed. This conclusion gives rise to the assumption that the waves with light speed which follow from our fundamental equation (1') – of whose simplest linear forms we have derived three variants here – could indeed be necessary and sufficient for the creation of reality.

I add one more consideration that plays a role in our argument:

In the set of all objects in the universe, let us look at the subset of elementary objects.

"Elementary" means that they cannot be further divided into objects and processes. So they are "structureless". It follows, in turn, that they are *without* time. But 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*.[7]

From this follows:

Objects are states of space-time.

4. Gravitation as Change of the Metric Density of Length

In this section 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 Subsection 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

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

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

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

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

$$\frac{dv}{dt} = -\frac{MG}{r^2} \qquad (7)$$

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'):

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

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

It follows $\quad d\sigma = -\frac{1}{c^2}\, v\, dv \qquad (8)$

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

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

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

Therefore $\quad C = 1$

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

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

(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 first section, 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 second section, 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 third section 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 the same section, 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 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 page 7 below.)

Let's denote the system from which we analyze the scenario as S. *S is not an observer system* – it is non-relativistic, we look at things (so to speak) "from the outside", but it allows 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):

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

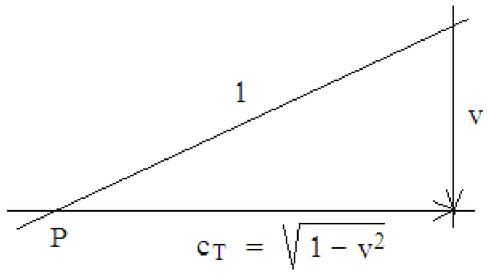
In r = 2m the speed of the flow v is therefore equal to the speed of light. This means that at a distance of 2m from the center, waves with light speed, which move against the flow direction, can no longer get out, but stand still.

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.)



(S4)

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

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

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

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

From this follows $\quad 1-\frac{2m}{r} = \frac{m}{r}$

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

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

As before, the tangential velocity must be corrected. If v_T is slowed due to the flow by the factor[8]

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

then, with respect to the acceleration

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

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

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

This gives $$r' = r - 2m.$$

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

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

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

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

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

8 In section 3 we found: *There is only light speed.* Thus, every motion must be thought of as composed of light paths. 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.

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

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

First we determine the length of the radial differential dr' of a non-relativistic system S' moving with the metric flow.

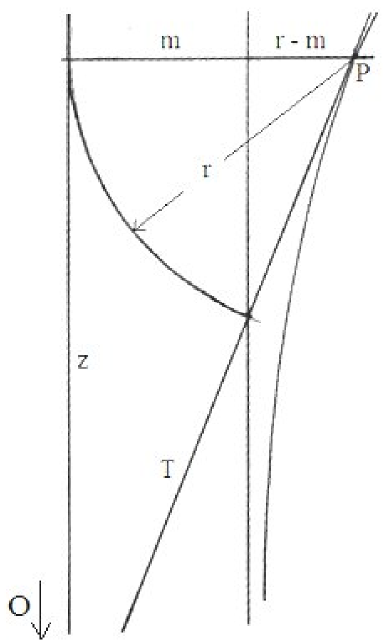
We start with the definition of σ from Section 1 (page 4):

$$dr = dr'\,\sigma \quad \Leftrightarrow \quad \sigma = \frac{dr}{dr'} \qquad (10)$$

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

follows $\quad \frac{dr}{dr'} = \frac{r - m}{r} \quad$ or $\quad dr' = \left(1 - \frac{m}{r}\right)^{-1} dr \qquad (11)$

The following sketch illustrates the metric conditions:



(S5)

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'

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 (S5) also shows that to point P the following applies: *before* the metric change, its distance from z is r (r ≥ m); *after* the metric change, this distance is r – m (expressed by the radial measure dr'). This applies to all Points, 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):

$$\sigma = \frac{r - m}{r} = \frac{r'}{r} \qquad (12)$$

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 an Einsteinian observer system S_E that is at rest relative 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_E. 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' of the *non-relativistic* system S':

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

As mentioned above, the factor by which dr' 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' to the relativistic flow system S_F? If the distance of a point P from O with respect to S' 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 of 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 of 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.[9]

9 The Schwarzschild metric, which is our goal, can actually be characterized by the fact that – seen from

Therefore in the transition from S' 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:

$$dr_F = (1 - \frac{2m}{r})^{-1} dr \qquad (14)$$

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_E, 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.

As we know, $$v = \pm c \sqrt{\frac{2m}{r}}$$

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

For the radial length differential S_E we thus get

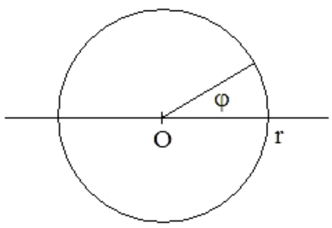
$$dr_E = dr_F\, k = dr\,(1 - \frac{2m}{r})^{-1} (1 - \frac{2m}{r})^{\frac{1}{2}} = dr\,(1 - \frac{2m}{r})^{-\frac{1}{2}} \qquad (16)$$

The time differential dt_E of S_E can be deduced from the calculations that we have carried out previously in this section. E.g. follows from *4.2. Closed Circular Path of Light* (see sketch (S4) on page 12), that for achieving constant light speed in S_E, the time interval Δt, which light requires for its way, must be reduced by the factor k. Therefore

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

The entirety of the local systems S_E results in the Schwarzschild metric.

Let r and φ be polar coordinates:



(S6)

Then applies:

any local system – the distance to the center is missing 2m units.

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

(18) holds for any plane through O.

(r dφ remains the same. The tangential differential has never 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,[10] then that point is a *source* of the universal flow field.[11]

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.

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

$$\frac{v}{c} = \pm\sqrt{2}\,\sqrt{1-\sigma} \qquad (19)$$

(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 The Structure of Reality, p.82 ff.), then v is imaginary. Except for the sign of v, the correspondence is inversely unique.)

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

11 However, there is at least one point, where the flow velocity starts with the value 0. (This point is, so to speak, the "highest" one with respect to the gravitation potential). So there is no real "inflow".

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

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

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

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

Previously, we denoted the differential of the resting system by dr_E, where E stands for "Einstein". However, this designation is no longer appropriate here, since in the general case 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.

For the time differential dt_B results

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

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

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 size 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).

5. Differences between the General Theory of Relativity (GR) and Metric Dynamic Gravitation (MD)

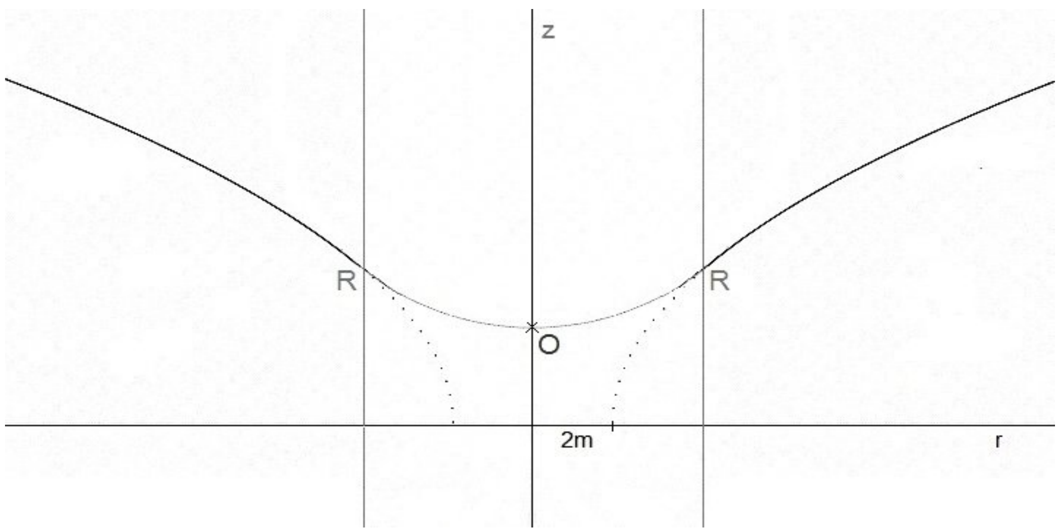
At the beginning, we stated:

In the spherically symmetric case of a single non-rotating mass – i.e. in the case of the Schwarzschild solution – GR and MD correspond to each other.[12]

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).

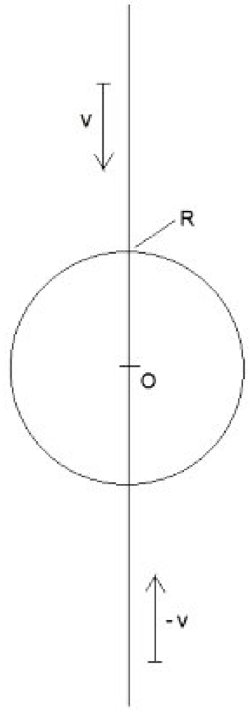
At point O, the slope of the curve, which represents the changed radial measure, is equal to 0. Therefore in O the radial differential dr_E is equal to the length differential of mass-free space.

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 MD the situation is as follows.

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

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



(S8)

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

According to the basic assumption of the MD, 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 → ∞.

However, as can be seen from (22) $[\, dr_B = dr\,(1 - \frac{v^2}{c^2})^{-1/2}\,]$, 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.

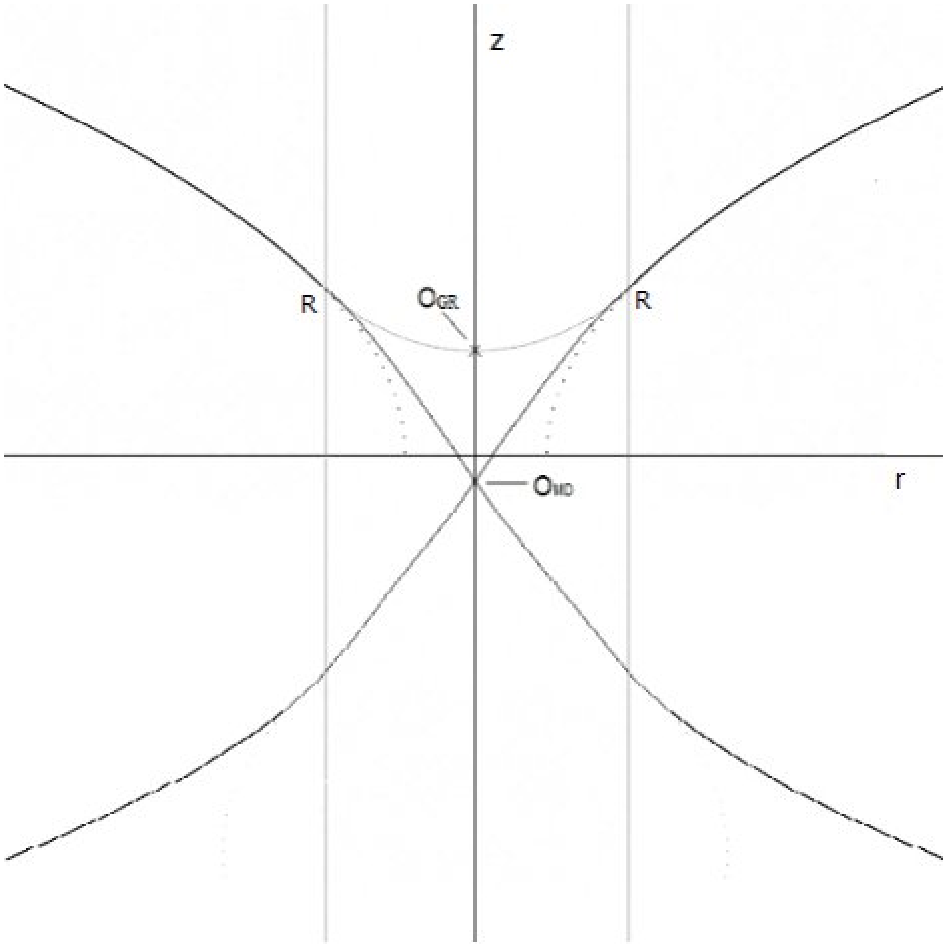
The scenario presented in (S8) also demonstrates why it is necessary to distinguish between ***space itself*** and its ***metric structure:*** along the vertical line through O, at every point there are ***two flows***: v(r) and –v(r), which are opposite to each other and have always the same absolute 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.[13]

(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.)

13 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*).

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



(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 MD 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 OMD 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)

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

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

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

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

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 results: (dt is the time differential in mass-free space)

$$dt(R) = 0{,}99999999931\ dt$$
$$dt(0) = 0{,}99999999896\ dt$$

In the MD, according to (23) to the time differential the following applies:

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

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:[14]

$$dt(R) = 0{,}99999999932\ dt$$
$$dt(0) = 0{,}99999999799\ dt$$

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, MD 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 MD 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 MD 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.[15]

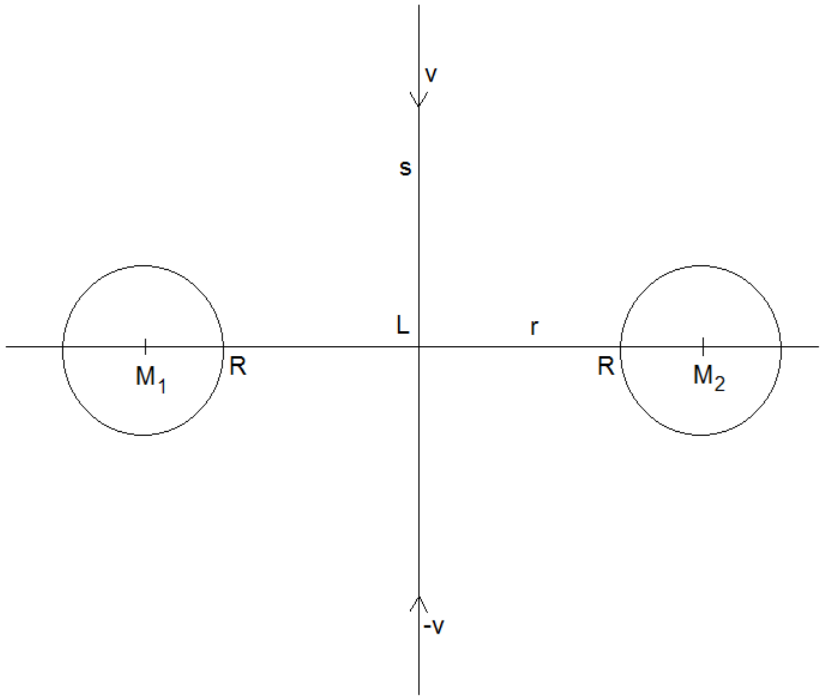
So much for the difference between GR and MD concerning the interior solution of the Schwarzschild metric.

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

14 The value for dt(R) is only valid at the North and South Pole. For other positions, a correction must be made due to the Earth's rotation, but this correction is the same for AR and MD.

15 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.

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



(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.

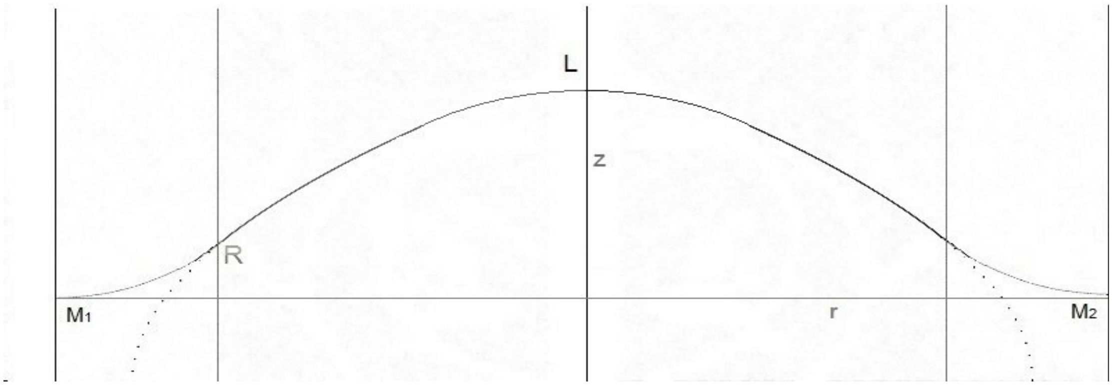
The two flow systems correspond to the freely falling systems, with which Einstein demonstrated the generalized equivalence principle, which states that not only uniformly moving systems but also freely falling systems in a gravitational field are (locally) indistinguishable. In GR, this is one of the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

MD, 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 MD. 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 MD 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.

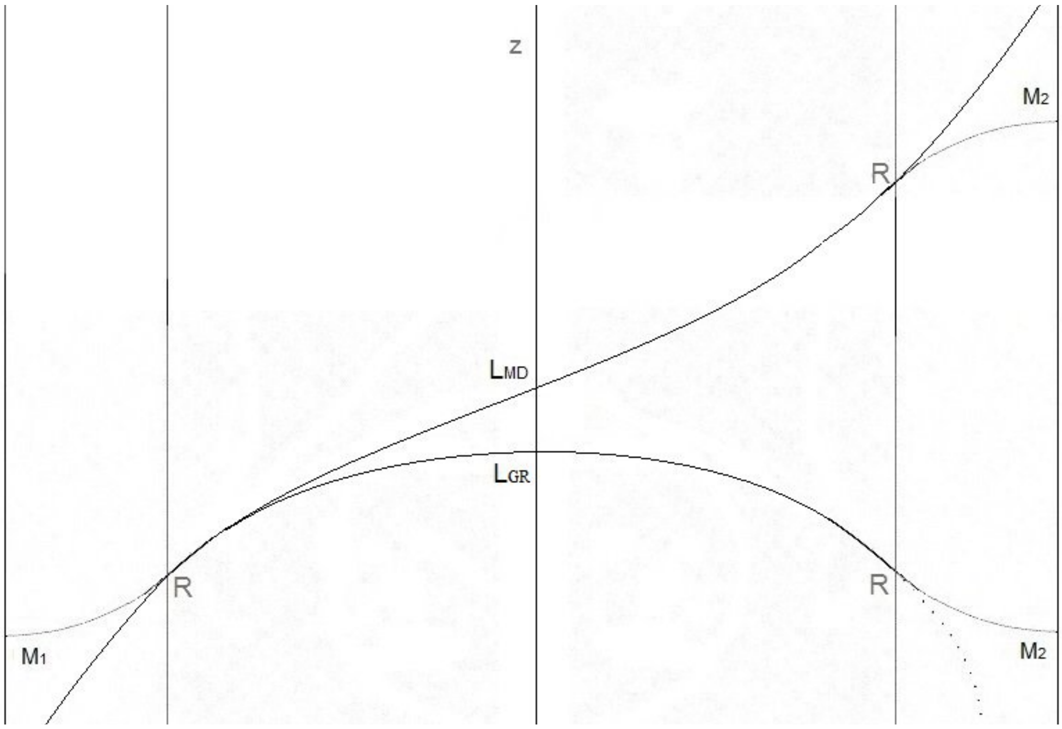
First we look at the metric conditions according to GR represented by an auxiliary dimension z:



(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 back to the comparison of GR and MD:



(S12)

Beginning bottom left and up to R, the curve first shows the interior metric of MD, then it corresponds in good approximation to the Schwarzschild parabola. But then the curve of MD 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 MD differ from each other. However, we will not analyze these differences any further, but turn directly to the question of how this differences 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 in relation to the length measure valid *in* the system. Relative to the outer measure (where $\sigma = 1$), 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.

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.

6. 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 MD, 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 MD, 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 occurs. 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.

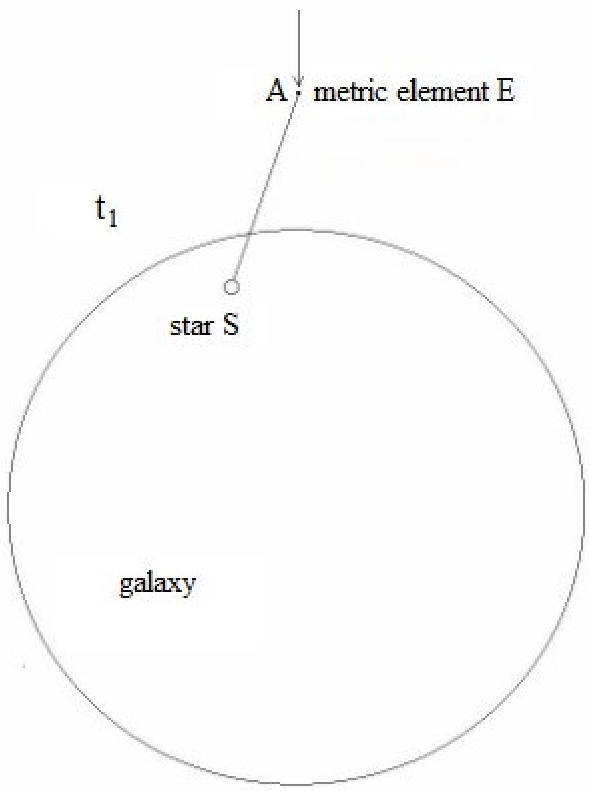
I will therefore carry out the argument in two steps: First I will show in more detail that from the assumptions which MD is based on it must be concluded that in galaxies the metric – or, for the sake of simplicity, let's say: *space itself* rotates, and then I will argue that this rotation of space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

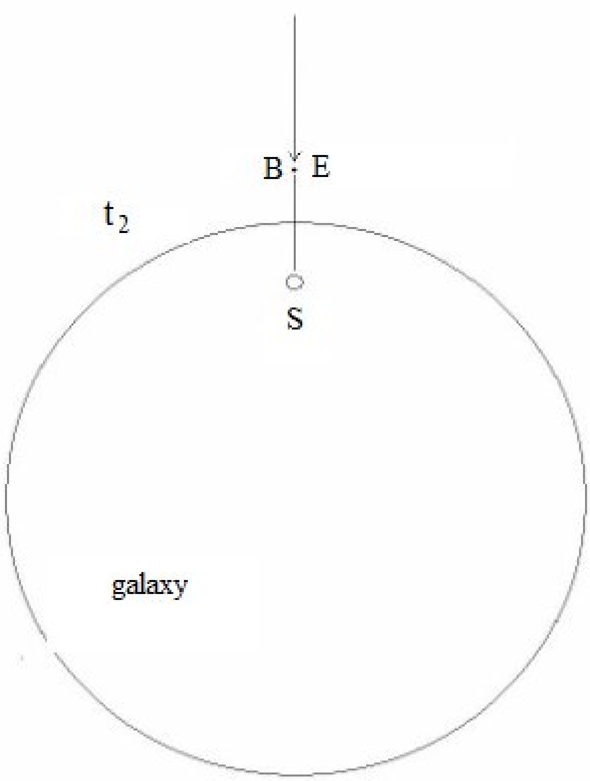
(S13): At time t_1 there is a metric element E at point A, which – falling freely from infinity – is accelerated in the plane of rotation toward the galaxy. (The finite propagation speed of gravity is irrelevant for the following reasoning, so we can ignore it.) Also shown is S, one of the galaxy's stars.

(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.

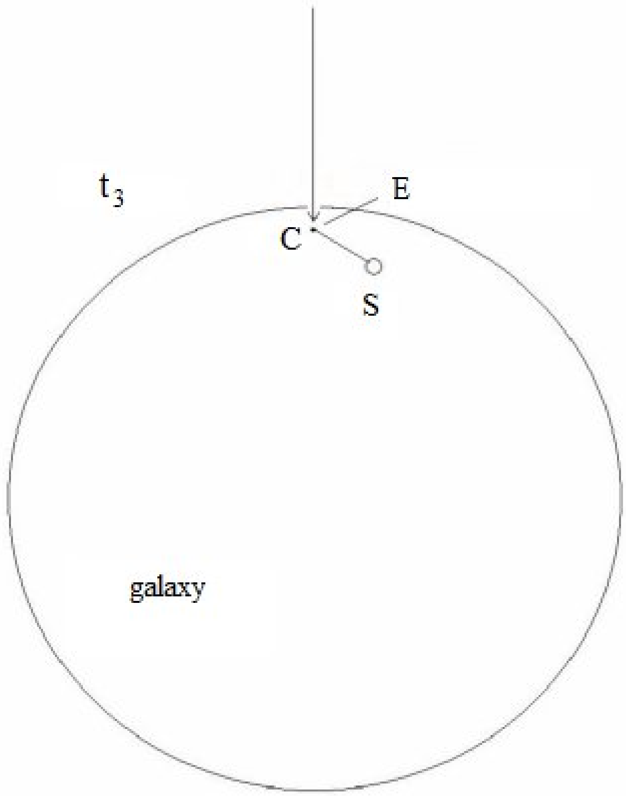
(S15): At time t_3, E has advanced to point C. ($t_2 – t_1 = t_3 – t_2$)


A
metric element E
t1
star S
galaxy

(S13)

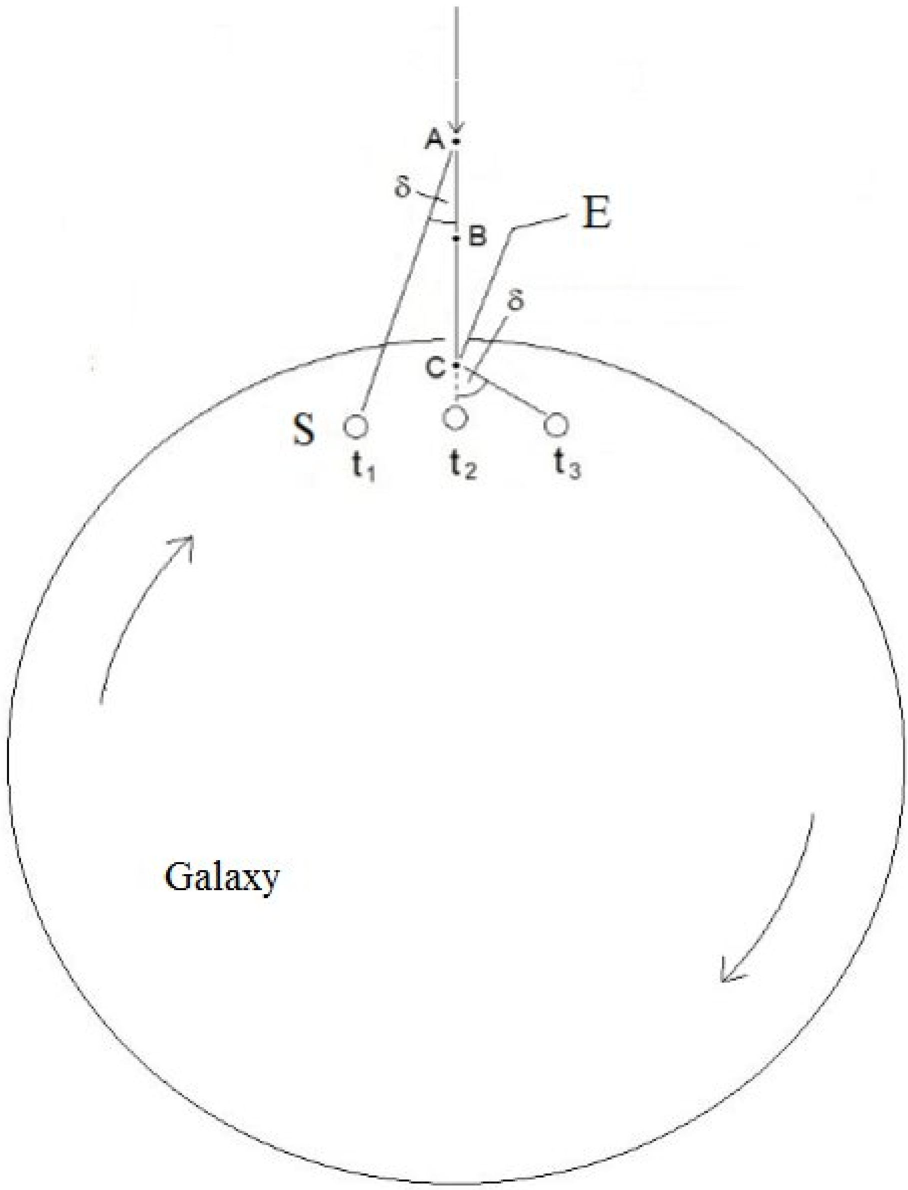

B
E
t2
S
galaxy

(S14)


t3
E
C
S
galaxy

(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 MD, S exerts an acceleration c^2m/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 MD 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

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

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

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 MD, 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 MD, 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 MD 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 MD 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 5 (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 MD 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.

6.1. 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 MD 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 MD, 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 MD. In all other cases, GR and MD differ from each other, as we showed in Section 5.

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 MD, 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 MD 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 MD can provide the explanation for this. But I didn't investigate it further.

7. 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 MD the gravitational effect does not occur instantaneously, but is transmitted with the speed of light.

MD 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 MD agree exactly with the results of GR. On earth and in the solar system, these two conditions are fulfilled in sufficient approximation.

This means: in the two scenarios where the most accurate tests of the theories of gravity take place, there is no measurable difference between GR and MD – 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 MD lead to the same results. This was demonstrated in Section 4.

However, as we proved in Section 5, 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 MD 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 MD the deceleration is almost four times greater than in GR, see Section 5, page 21/22.)

The radial differentials are identical only on the outside, but toward the center they become longer in the MD 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 6. 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 MD, 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

MD compared to GR, the geometric methods of GR can still be used, but the changes of the metric must be taken into account.[16]

To 3.) The extent of the deviation of GR and MD 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 MD 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 6, 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 MD 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 MD 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 MD 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:

Contrary to the theories that emerge from Newton's or Einstein's theory through *ad hoc* modifications, the MD 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 MD, as a consequence of the metric flow, which does not exist in GR.

16 However, initially only the values of the differentials parallel and orthogonal to the respective flow direction are directly accessible, see Section 4.6, Equation (22). The length differential perpendicular to the direction of the flow remains unchanged, i.e. it corresponds to that of undistorted space. (23) gives the time differential.

8. 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 MD 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 MD. 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 MD, 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 mentioned at the beginning (in the footnote on page 4) 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 MD – 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 them.[17]

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 MD, 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 MD, 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 MD, 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

17 Here, "derived" has the following meaning: If the geometric mass m of an object is known, it can be weighed. The unit whose multiple is displayed on the scale can then be defined as "kilogram". This connects the geometric mass with experience.

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 5 and 6 of this paper, this applies indeed to *all* cases except one: the case of a single, non-rotating mass.

From the point of view of the MD, the reason for this deficiency is that the central concept of MD – 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 arbitrary.

In the case of MD, the situation is quite different: the MD follows from considerations about the origin of reality and from the continuation of Einstein's analysis of the temporal conditions. 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 MD 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 Section 4 of this paper. 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 MD differs from GR.

However, the magnitude of the difference between GR and MD has only become clear to me in the past three months that I have spent writing this paper. 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 MD 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.

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