

About an Anomaly that challenges Relativity

Mach's Principle versus Principle of Radical-Non-Duality

A paper

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Abstract: The first step in scientific revolution or paradigm shift is the awareness of the existence of an *anomaly*. It means to see clearly that a special fact cannot be explained by an universally accepted paradigm.

Although relativity - one of the most driving paradigm of contemporary physics - is working efficiently in the most cases there is one fact, which cannot be explained by it.

This fact concerns a specific *coincidence*. Physicists have observed that the local inertial compass coincides with the frame of the most distant galaxies and quasars within the present measurement accuracy of 2.5×10^{-4} arcsec/year.

In modern physics *Mach's Principle* is the most favoured hypothesis to explain this fact. It maintains that the local inertial compass, *f.e.* Foucault's pendulum, is determined by all the masses in the universe in such a way that the measured coincidence is given. As Mach's Principle implies that not only gravity but *all* physics shall be formulated without any reference to an all-pervasive background like an ether, it is physically considered as the climax of relativity. But Mach's Principle could never be formulated in a precise way. The above mentioned coincidence is thus still unexplained. But it is not yet *epistemologically* recognized as an anomaly that challenges the relativistic paradigm.

In this paper an argument is presented that could change the epistemological status of this fact tremendously. Actually this fact can be explained as the 'signature' of an *omnipresent* and *invisible* meta-ether.

“Science in the twenty-first century will be spiritual, or it will not be.”
Andre Malraux

I. Mach’s Principle or: A history of Failure

Relativity is obviously one of the most important paradigms of modern physics. It is in fact more than a specific physical theory. It is a whole view of the Universe. According to this view all motion is essentially relative. There is no absolute background, f.e. an absolute space or ether or something else, to which the motion of a body is referred.

Although this paradigm was criticized right from the beginning it resisted all attempts to overcome it which were tried during the last one hundred years. No unexplainable fact so far seems to be recognizable. But actually there is such a fact. Physicists have observed that the local inertial compass coincides with the frame of the most distant galaxies and quasars within the present measurement accuracy of 0.00025 arcsec/year.[1] This coincidence was circumscribed by the German physicist Hermann Weyl as the »coincidence of the inertial compass and the stellar compass«.[2]

This observed coincidence has a highly symbolic meaning: Its explanation is considered as the peak of relativity. Through this explanation it shall be demonstrated, that all motion (including the accelerated one) is really relative. But until today this final step could not be done. More than one hundred years of relativistic thinking were not sufficient to break the secret of this fact. It is physically still unexplained.

The way to explain this fact in a relativistic manner is known as *Mach’s Principle*. It goes back to Ernst Mach. Mach was the first physicist, who pointed out that the coincidence of the inertial and the

stellar compass might be of nontrivial character. This was in 1883.[3] But Mach was not looking for some strange facts of the Universe. He recognized that just this coincidence supported his epistemological viewpoint. Mach's epistemology was ruled by the wish to free mechanics, optics and other physical branches from metaphysics, *i.e.* from all terms which were unobservable. According to him the scientific reasoning should be limited to the world as it is: to the world of observables. He saw no compelling reason why physics should rely upon 'metaphysical' artefacts. And the Newtonian term of an absolute space was such a metaphysical term: it was unobservable. There was no possibility to determine the space coordinates x_1, x_2, x_3 . Only relative distances in connection with material bodies were observable. And Mach discovered, that the coincidence of the inertial and stellar compass offered the possibility to substitute the metaphysical term of absolute space by something observable: *the frame of the fixed stars*.

For more than two hundred years the metaphysical notion of an absolute space had repugnantly to be accepted as the cause of inertia, but now the fixed stars resp. their masses could be assumed as this cause. By this assumption the relational view of motion began to dominate physical thinking for the next one hundred years - until today. Although the Newtonian term of absolute space was repeatedly attacked by several thinkers as being without meaning, *f.e.* by Bishop George Berkeley, none of these attacks had any lasting effect. Newtonian mechanics was a highly successful paradigm: It provided a firm basis for natural philosophy. Newtonian mechanics celebrated not only brilliant success in astronomy, it allows to explain convincingly the continuous motion of fluids and the vibrations of elastic bodies. Even the theory of heat could be reduced to mechanics.

By Mach's discovery of the coincidence of the inertial and the stellar compass the situation changed: the relational view began to grow. Of

course, for several decades it still remained on the fringes of the physics community, because Mach gave no detailed explanation of how such a material interaction between the local inertia and the fixed stars took place. He made only tentative proposals. But the marginal place of the relational view within the world of science ended nearly abruptly as the young physicist Albert Einstein followed the Machian way of thinking. By trying to incorporate the Machian view into his General Theory of Relativity (GTR) it moved successively from these fringes to the mainstream. Today the Machian view is inseparable part of the relativistic paradigm. Nowadays inertial forces experienced by accelerating bodies are commonly interpreted as the result of some kind of global interaction with the masses of the fixed stars.

The most important step which led to this change was made by Einstein himself as he gave the Machian relationism the epistemological status of a *principle*. By this act the relationism was sealed as being fundamental. In 1918 Einstein wrote in a paper on the general theory - "Prinzipielles zur allgemeinen Relativitätstheorie" -: "*Mach's Principle*: The G-field is without remainder determined by the masses of bodies. Since mass and energy are, according to the results of the special theory of relativity, the same, and since energy is formally described by the symmetric energy tensor ($T_{\mu\nu}$) this therefore entails that the G-field be conditioned and determined by the energy tensor." [4]

Since that time the relational view is not only regarded as the *exclusive* way of explaining the origin of inertia, this exclusiveness includes also the fact of the coincidence of inertial and stellar compass. Sometimes physicists do not even differ between the empirical fact and the theoretical approach, i.e. Mach's principle. Without referring to the observational basis they are simply talking about 'Mach's principle'. By this specific reading the fact itself is physically received in such a manner that all other explanations are

implicitly condemned. Mach's principle is considered as the only serious scientific route to such an explanation. This narrow-minded attitude is guided by the hope to crown relativity with success. It shall be demonstrated that *all* physics can be formulated without any reference to an all-embracing background, f.e. absolute space or something else.

But until today the history of Mach's principle was a history of an unending series of scientific defeats. All attempts to explain the coincidence of the inertial and the stellar compass in the spirit of relativistic thinking failed.

Einstein himself struggled his whole life for this aim. But quite early it became clear that his GTR did not satisfy Mach's principle. Although GTR supplied a dynamic spacetime, which was dependent on the matter distribution, it did not fulfill the demand of using solely relational properties between material objects. Einstein himself tried different ways to remove this deficiency. One of these ways - the assumption of boundary conditions at infinity - is discussed later. But at the end of his life he denied the futility of this principle. In a letter to Felix Pirani (1954) he declared that one should no longer speak of Mach's principle *at all*.

Although GRT failed evidently in explaining this fact, no contemporary physicist would take into account that just this fact is an anomaly which reveals relativity as a limited and even highly misleading view of the Universe. If we look for a reason of this almost collective ignorance we will discover that there is still no other paradigm, which can provide a striking explanation of this fact. The only alternative paradigm we know is the Newtonian one. But neither Newtonian gravitation theory nor Newtonian cosmology can provide any explanation for this observational fact: "In Newtonian theory there is nothing a priori to predict this, it is simply a coincidence." [5]

Einstein's GTR is indeed the only theory, that can provide, at least in principle, a certain kind of explanation.[6] But there is growing number of scientists who are realizing that the coincidence of the inertial and the stellar compass is something special, which goes far beyond physics as we know it. In the following chapter several statements are collected.

II. Voices of Hope

Prof. Herbert Pfister is a theoretical physicist at the Institute of Theoretical Physics (University of Tübingen), who worked mainly on GTR. In 1993, he and Julian Barbour organised an international workshop on Mach's Principle in Tübingen, Germany. Nearly all the leading physicists in the world who have worked on the issue attended, as did numerous philosophers and historians. The workshop proceedings were edited as volume No. 6 of the Einstein Studies: *Mach's principle - From Newton's bucket to Quantum Gravity*. This book has become a standard reference for Mach's Principle.

Already in this book Pfister labeled the coincidence of the inertial and the stellar compass as a *remarkable fact*. [7] But some years later he published a paper in the *Foundations of Physics Letter*, in which he chose almost religious terms:

„...the greatest wonder .. is the following „cosmic coincidence“: Imagine a physicist performing experiments in a closed local laboratory, especially determining (...) the local inertial systems. Having finished this, he opens the „windows“ of his laboratory and looks to the distant stars, galaxies, quasars, and to the cosmic background radiation. And then he is (hopefully) amazed beyond all expectation that there is no acceleration, especially no angular

velocity ω between the local inertial system and the „cosmic rest system“. [8]

This announcement given by a professional and acknowledged theoretical physicist may sound unbelievable but it is by no means a solitary comment. There are few others similar comments – all given by physicists.

“Although we can all recognize the strong pervasive unity of *form* in the universe, there is a compulsive desire to search for a deeper cosmic unity, one which weaves together our own local region with the grand totality in some intimate way. Linking the large and the small ... has a strong appeal because it makes us feel at one with all the creation, a mystical objective common to most of the world’s religions. Many people doubtless feel themselves to be linked spiritually to the totality of things, but there is also a parallel tradition in science for forging such links.”[9]

This comment stems from Paul Davies - and Paul Davies is a theoretical physicist, too. And what he is announcing here is nothing else than Mach’s Principle. In his following comments we can observe a typical way of speaking about this issue. Actually Davies leaves no room between the explanation, i.e. Mach’s Principle, and its observational basis, i.e. the coincidence of the inertial and stellar compass. Mach’s principle is all what we get. It reveals the intellectual atmosphere that surrounds this specific fact. Though it is felt clearly that it challenges the current paradigm, it is still described in terms of it.

But some physicists do take the risk of looking beyond and making some highly speculative remarks, f.e. the astronomer Trinh X. Thuan, who teaches at the University of Virginia: “In any case, the behavior of Foucault’s pendulum [i.e. to be aligned to the most distant galaxies and quasars] forces us to conclude that there exists a sort of interaction totally different from those described by recognized physics, a mysterious interaction that does not involve any force, nor

exchange of energy, but that connects the whole universe together.”[10]

The German theoretical physicist Friedrich Hund has described this coincidence even as *uncanny*. [11]

The way all these physicists are talking about the coincidence of the inertial and the stellar compass whether implicitly or explicitly makes clear: This coincidence is considered as a highly important fact that transcends our current physical paradigm.

Usually coincidences are, in physics, considered as a distinct and clear sign that something fundamental is going on [12], but *this* coincidence is widely ignored by the scientific community. Sometimes physicists are emphasizing the approximate character of this coincidence following the line: *no coincidence – no secret – no need for an explanation or even a new theory*. In the already mentioned book *Mach’s principle* a little dialogue highlights this kind of thinking[13]:

Jones: Mach pointed out that the inertial frames we observe do not rotate relative to the stars as we see them, and I would say any theory has to explain why that seems to be the case.

Lynden-Bell: None of us believes it’s true though ...

Barbour: You think it’s only approximate, Donald?

Lynden-Bell: Yes, I think it’s only approximate, and I think most people think it’s only approximate.

Jones: Yes, but it’s approximate to a very high degree of accuracy.

Lynden-Bell: No more accurate than you would expect.

Jones: No, I think there are actually observations to show that it’s quite accurate.

Lynden-Bell: Quite accurate, but no more accurate than one would expect.”

Sometimes physicists even deny the existence of this factual coincidence. They describe it as being simply of illusory

character.[14] In this paper I like to show that this coincidence could be far more important than any other coincidence we have already observed and examined. *In fact it could be the signature of a transcendent branch of reality, which is metaphysically called the One.* For this invisible and thus unobservable branch we have been searching since more than two thousand years in vain. Today metaphysics is even regarded as completely meaningless, because most philosophers believe that metaphysics can never satisfy the 'Principle of Verifiability'. This states that we know the meaning of any sentence only if we know what it would take for that sentence to be true. If there is no method of verifying it, at least in principle, then the sentence is meaningless. As the One is of transcendent character there seems to be, in principle, no method of verifying the sentence: *The One does exist.*

However, the introduction of this principle into philosophy has the devastating effect of making metaphysics literally meaningless. Until today not a single meaningful metaphysical sentence could be formulated. In this paper such a sentence is presented. It is considered as the very first step of initiating a modern metaphysics.

Before I will justify this far-reaching assertion I like to clarify the factual coincidence, because it necessary to refer to it in its modern version, because only this modern version is precise enough, in order to recognize a very close relationship between this empirical coincidence and the theoretical coincidence, that is metaphysically recommended.

III. About an uncanny Coincidence

The coincidence of the inertial and the stellar compass in its original form, as it was exposed by Ernst Mach the first time, is very

unspecific. The inertial compass is referred to a local dimension and the stellar compass to a global dimension. How unspecific these references are, becomes clear, if we look at the global dimension. The global dimension is totally vague and undefined: it is merely related to the fixed stars. No specific stellar object or a group of such stellar objects is distinguished. In some modern textbooks about relativity this unspecific version is still described: "There is one very outstanding and simple fact that lends support to the Machian viewpoint. Consider a pendulum set swinging at the North Pole. According to Newton, the pendulum swings in a frame which is not rotating relative to absolute space. In this frame the Earth is rotating under the pendulum. An observer fixed on the Earth will see the pendulum rotating. The time taken for the pendulum to swing through 360° is therefore the time taken for the Earth rotate through 360° with respect to absolute space. We can also measure how long the Earth takes to rotate through 360° relative to the fixed stars. The remarkable fact is that, within the limits of experimental accuracy, the two times are the same." [15]

Today we know, that the local inertial compass is not simply aligned to the fixed stars. The stars of our Milky Way, of the Local Group and even of the Local Supercluster are excluded. In all these cases a drift of the plane of oscillation of Foucault's pendulum can be observed. Only on a scale *much larger* than all these groups of stars the inertial compass, i.e. Foucault's pendulum, seems to be aligned, that is, to the frame of the most distant galaxies and quasars. [16]

Although Mach's version of the coincidence of the inertial and the stellar compass differs considerably from the modern version, it was the Machian view that curiously encouraged this precise measurement. In fact it contradicted the simplest of observation. When a body rotates, it is acted upon by centrifugal forces, but the presence of these centrifugal forces seems to be completely independent of whether the body rotates with respect to bodies

immediately surrounding. This contradiction made clear that mere the most distant stellar masses could play the decisive role in fixing the inertial force on a given body. It was just this contradiction that forced physicists to examine this factual coincidence more precisely. Today the coincidence between the local inertial compass and the most distant galaxies and quasars is measured in the already mentioned accuracy of 0.00025 arcsec/year.[17]

Although the Machian view has essentially smoothed the way to the perception of this coincidence its *materialistic* explanation by the relativistic paradigm is highly misleading. There is indeed no other fact so far in which the erroneous character of relativistic thinking becomes so obvious as it is in this specific case, because just this fact, which is still reserved of accomplishing the relativistic dream, could ironically be the empirical signature of an omnipresent and invisible »meta-ether«, to which all things of the Universe are referred.

IV. The methodological turn

A coincidence is given if two elements, f.e. A and B, are the same. There are, in general, two ways of explaining such a coincidence.

(1) *You can assume, that A is determined by B (or vice versa)*

or

(2) *you can assume, that A and B do have a **common source** – an **identical origin**.*

In modern physics the coincidence of the inertial compass (A) and the stellar compass (B) is almost exclusively explained on the first

way: The inertial compass (A) is determined by the global distribution of stellar matter (B). This explanation is already presented: it is 'Mach's Principle'. But until today no one has yet come up with a successful and elegant theory, that satisfies this principle. Later I will present an argument for this failure; an argument, which was already mentioned by Albert Einstein himself.

First of all I like to present a theoretical approach, that gives us the possibility to explain the coincidence of the inertial and the stellar compass on the second way. I am calling this explanation the *Principle of Radical Non-Duality*.

According to this principle the inertial and the stellar compass do 'coincide' because both compasses do have a common source – something, which is metaphysically described as the One. Physically we would probably use the term 'Meta-Ether'.

At the first sight this explanation may run counter to all our experience about metaphysics, that is, metaphysics can never be a science. But that's not true. Metaphysics can be a science as well as atomic physics. But in order to recognize this possibility clearly we have to abandon *unrealistic expectations*. And this step is the most difficult one, at least from a purely psychological point of view.

What metaphysics makes scientifically difficult, is only one thing: We have to accept a *limit of knowledge* which is going far beyond all known limits. As already the history of quantum mechanics has shown sometimes this step cannot be done even by a genius.

As the physicists explored the world of the atom they were forced to accept that an electron is not moving on an orbital path around the nucleus. Instead of that they had to accept, that it is staying in a »cloud« which could only be described by a complex wave function – the core of quantum mechanics. But this function allowed them to compute only the *probability* of finding an electron in a particular region around the nucleus at a particular time. Contrary to classical mechanics, they could not – in principle – make exact predictions of

position and momentum *at the same time*. An electron could only be considered as being located »somewhere« within a region of space. By Heisenberg's uncertainty principle the physicists were at least able to quantify this inability to locate the electron.

Albert Einstein himself disliked this loss of determinism in the measurement of the motions of an electron. His famous quote - "God does not play dice with the universe." - is directly related to this aspect of atomic physics. And he held this opinion his whole life. He never accepted this limit of knowledge about reality. He held that there should be a local hidden variable theory underlying quantum mechanics. He produced a series of objections to the theory, the most famous of which has become known as the *EPR paradox*. In 1964 the physicist John Bell showed that the EPR paradox led to experimentally testable differences between quantum mechanics and local theories. In 1982 these differences were measured. They have been taken as confirming that quantum mechanics is correct - in spite of its loss of determinism.

In the case of metaphysics we have to accept far more than a well defined loss of determinism. Actually we have to accept that the most fundamental entity of our Universe, i.e. the One, cannot be grasped neither experimentally nor theoretically. If the One is really of *transcendent* nature, then it is beyond every scientific access. There is no formalism we can relate to. The loss of determinism is indeed total. We cannot, in principle, point to anything. To accept this conclusion, that's in fact a great challenge of the scientific mind. If something cannot be measured, so it is usually regarded of being unknowable by science. Up to this day no one has accepted this conclusion, that is, no one has really accepted that the One is really of transcendent nature. The One is simply considered as scientifically *meaningless*. That's the tragedy of modern physics. Physicists are intensively looking for a 'Theory of Everything', hoping to get a *complete* understanding of reality, but the most important 'thing', i.e.

the One, is left out. However this 'Theory of Everything' may look, if the most fundamental entity or quantity of our reality is not taken into account, it will be more a 'Theory of almost Nothing'.

It may sound paradoxical, but only if we accept transcendence as a real and essential feature of the One, metaphysics can be developed in a scientific fashion. It is the very first step into this direction. If this step is not done, no further step will follow. As long as we do not accept this property of transcendence we try to grasp and to measure something, which cannot by its intrinsic nature be grasped or measured. In brief, we are hopelessly trapped. If we like to initiate metaphysics *as a science, we have to turn around and to look at the physical Universe*. This is the only place, where the scientific method can be applied, because only here experimental data can be expected. This change of perspective - from the invisible One to the visible Universe - I am calling the "methodological turn". It may appear very easy to take this methodological attitude, but actually it is the most difficult one. For the scientific mind it is almost unacceptable to work on something really fundamental without grasping or touching or measuring it.

In the following chapter I like to report about this psychological or mental obstacle and how it could be overcome.

V. About the discovery of the »Threshold Area«

If we like to precise the physical conditions that are connected with the One, we have unavoidably to deal with metaphysical properties like Omnipresence, Invisibility, Absoluteness, Oneness etc. These metaphysical properties are the only material we can work with. They are the heritage of the *philosophia perennis*.^[18] But this work

urges us into the already mentioned unsolvable problem of metaphysics: the impossibility to describe and formalize something, which cannot, in principle, be described and formalized.

For me it becomes a painful lecture as I tried to answer the question: Which conditions must the physical universe fulfill in order to base upon something omnipresent? I chose this attribute of omnipresence, because it was not only a typical term of metaphysics but of physics as well. Physical terms like the ether, the absolute space, the vacuum and even the Higgs-field were considered of representing something omnipresent.

As I started to think about this specific property, there seems to be no chance to determine the physical conditions connected with omnipresence. If the structure of the Universe should actually be compatible with an omnipresent foundation, then it had to guarantee that this foundation was present *at all points* of the visible Universe, because this was exactly the meaning of omnipresence. But this meant - in the inversion of this argument -, that *none of these points* was in any way metaphysically preferred. Consequently, there didn't seem to be any specific point that lent itself of proving the existence of this foundation *in a non-trivial way*. A trivial way was indeed near at hand: If an omnipresent foundation of the physical universe is supposed, then you can of course claim, that all points of the world were proving the existence of this foundation. Though this argument may be not false, it is certainly trivial. In order to get a more meaningful argument it was necessary to find a somehow specific or preferred point. But following the metaphysical term of omnipresence no point of the Universe seemed to be better than an other. In brief, I got a victim of an unrealizable epistemological expectation that lay at the heart of a metaphysics - I got a victim of the wish to describe something in scientific terms, which could not, in principle, be described in such terms.

To be able to get out of this trap, I had to recognize clearly, that there could be, in principle, no scientific answer so far. If there was a scientific answer at all, then it could exclusively be found within the physical Universe. That was the only place where science could be successful, because only here empirical data could be found. That's the message of the 'methodological turn'.

In my own painful 'lecture' it opened up to me the way to the discovery of a very specific area of the Universe - of something, which I am calling the *Threshold Area*. As all my attempts to grasp the One painfully failed, I asked myself: If all facts are really limited to the visible Universe, what was the best place in our Universe, to find purely meta-physical facts? In other words: Where could the existence of the One be proved experimentally in the best way?

The most interesting place was surely the area very close to the limit of the One, because here *two specific conditions* came together.

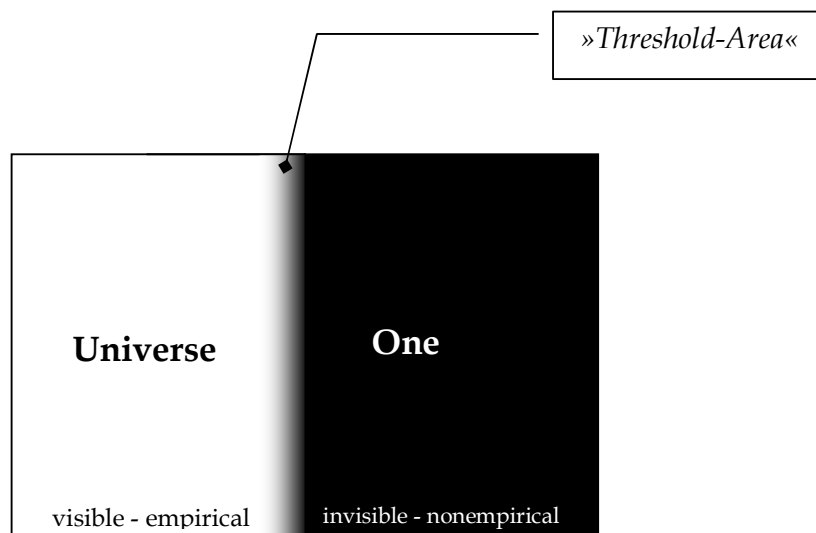
(1) There was no other area of the physical Universe, in which the epistemological distance to the One, *i.e.* the realm of Transcendence, was *so little* than here. If there was any area in our Universe, in which we could see the »shadow of the One« in the most clear and direct way, then it was in this very specific area.

(2) In spite of this vicinity to the One the »Threshold Area« provided at least a few empirical data, because it was epistemologically still part of the empirical side of reality, *i.e.* of the visible physical Universe.

Out of these two specific conditions the Threshold Area appeared as the most interesting point to prove the existence of the One *in a scientific way*. The discovery of this area was certainly the most important step towards a modern metaphysics. Every further meta-physical insight which should come followed out of this step. It

shows how important the 'methodological turn' is. We have to be aware of it, because in metaphysics we are always in danger to get lost in the field of transcendence. And that means, we try to grasp something, which cannot be grasped.

As I studied the Threshold Area more intensively, I discovered, that I was not the only person, who was interested in this strange twilight-zone of the Universe. Already several researchers had ventured to this area - and they were returned home of their intellectual journeys with some very interesting insights. But unfortunately these insights were dispersed over different disciplines. Some insights were at home in modern physics, some originated from the philosophy - and a lot grew in the theological field of research.



This dispersion had historically led to the fact that they remained largely unnoticed. Within the different disciplines all these insights represented comparatively isolated knowledge. They appeared as loose ends which seemed to be connected with nothing. But if one look at these insights *sub specie aeternitatis* then they suddenly appear as parts of an unexpectedly concise picture; a picture which shows clearly: *The One isn't a legend, it is an empirically provable reality*

The most meaningful of all these different pieces of knowledge I tracked down to a time five hundred years in the past. It was discovered by a man named Nicolaus Cusanus, an important philosopher of 15th Century. It offered in fact a nontrivial version of describing the property of omnipresence.

Before I will introduce this version, the general idea behind it shall be explained, because this nontrivial version is integral part of something, which I have already announced as 'Principle of Radical Non-Duality'.

VI. The Principle of Radical Non-Duality

Usually the property of transcendence is metaphysically regarded as a negative one, because it prevents us from making any meaningful scientific statement about the One. As long as stick to the One this conclusion appears as evidently true, but if we follow the methodological turn, turning around our perspective and looking at the physical Universe, this conclusion appears less true: If we contemplate about Transcendence *with respect to the structure or conception of the Universe* more deeply, then we will discover, that transcendence is *a very restrictive physical condition* which limits probably the spectrum of possibilities how the physical Universe can look like in such a way, that only *one* structure is likely.

When the physicist Albert Einstein developed his theories, he wondered whether God had a choice in the creation of the universe or not. By looking at things from the perspective of God he tried to find out whether the Universe had to fulfill certain conditions, for example the condition of logical simplicity, or not. If one starts to think about *transcendence* in this way, then an interesting kind of conclusion comes up: If God wanted to set up the Universe so that

He remained completely invisible on its stage, then the Universe must have unavoidably a very special conception. If it would be possible to precise the specific conditions of a »conspirational« conception in a physically predictable way then we can empirically check whether our Universe does have such a conception or not.

But what kind of conception had to be supposed in order to secure the invisibility of the One? *Actually it was a certain kind of a radical non-dual conception.*

The general idea behind this conception is very old. It is even part of traditional metaphysics. According to this idea the One is defined as an all-embracing essence, in which *all differences* of the visible Universe are melted into. This definition includes implicitly a rational explanation, *why* the One is invisible.

In general, an entity can only be seen, if it is distinguishable towards other entities. If there is no difference left, then it cannot, in principle, be seen: *It is, in principle, invisible.* Hence, to secure the demand of invisibility the Universe has to satisfy a very restrictive condition, if it likes to become radical Oneness: *All its differences has to be solved and turned into coincidences.*

Although this non-dualistic view of reality provides a clear and rational explanation of the metaphysical property of transcendence resp. invisibility it was never investigated systematically *in a physical context.* But we can do that. By the transposition of this very old idea into a modern context several things have to be changed, but the conceptual core of this view can be saved.

In order to "make" the One totally invisible, it was as I recognized not necessary, to turn all differences *of all areas of the physical Universe* into coincidences, but only those differences, which were related to the already mentioned *Threshold Area:* If the One should really be invisible at least in this specific area all differences had be extinguished, because no other physical level ground was left over. If the Universe failed in sealing up its last level ground, the invisibility

of the One was in danger. But what type of differences was referred to this specific area? It was the philosophy of Nicolaus Cusanus that yielded the decisive information.

VII. The first sentence of a Modern Metaphysics

Nicolaus Cusanus (1401-1464) was the most important philosopher of the 15th century. Primarily because of his dialectical reflections on the nature of the One. The cornerstone of his philosophical work is the *Doctrine of the Coincidence of Opposites* (or in Latin words: *Coincidentia oppositorum*), which he published in his work *De docta ignorantia* (On Learned Ignorance) 1440.

By a systematic application of this doctrine Nicolaus Cusanus gained some very interesting insights about that area, which is called in this paper the 'Threshold Area'. [19]

In his book *De Docta Ignorantia* he wrote:

".. since the absolutely Maximum is all, that which can be, it is altogether actual. And just as there cannot be a greater, so for the same reason there cannot be a lesser, since it is all that which can be. But the Minimum is that than which there cannot be a lesser. And since the Maximum is also such, it is evident that the Minimum coincides with the Maximum." [20]

This statement - the coincidence of the Minimum and the Maximum - revealed what kind of differences had to be related to the Threshold Area: *It was the class of the most extreme ones.* [21] According to the Principle of Radical Non-Duality all these differences had to be solved and turned into coincidences, if the field of the One should be sealed up.

Although the coincidence of the Minimum and the Maximum was of very general character it could be specified physically. The most

obvious physical coincidence, which could be derived, was the »coincidence of the Smallest and the Largest«. [22] This coincidence revealed surprisingly how the metaphysical attributes of omnipresence *and* invisibility was physically »encoded« into the structure of the Universe in a nontrivial way. To understand this possibility, no difficult theoretical operations are necessary.

If an entity shall be the omnipresent basis of the whole universe it must satisfy at least two conditions: At first it must contain or embrace all things of the Universe. Secondly, it must also be contained in all these things. Only if an entity satisfies these two conditions it can be considered as the omnipresent foundation of the universe.

The coincidence of the Smallest and the Largest includes just these two conditions. If something is the Largest it can contain and therefore embrace all things of the Universe. If something is also the Smallest, it can be contained in all these things as well. But the coincidence of the Smallest and the Largest includes far more: It also secures, that this omnipresent foundation cannot, in principle, be seen from a point within the physical Universe, because the relation of the Smallest and the Largest is *the most extreme difference* of the Universe. The Universe cannot, in principle, have a difference which is more extreme than the relationship between the Smallest and the Largest: *it describes its ultimate limit*. If we solve the difference of these two extrema by the demand of coincidence then our next step will lead us *directly* into an invisible realm because no further difference of the visible Universe is left. The One is successfully sealed up.

If we put together all these insights about the coincidence of the Smallest and the Largest, then we can see that it is a highly effective physical condition: *It connects the physical Universe with the One in such a way, that it is everywhere in the Universe but no one can see it*.

It was this very insight that had to be attained by metaphysics. It unveils us that transcendence/invisibility includes a very restrictive

and thus very specific physical condition. Only the coincidence of the Smallest and Largest seemed to provide the possibility of realizing omnipresence and invisibility *at the same time*. It evoked thus the feeling of *inevitability*. Its scientific message was clear: It described in an exemplary way how a radical non-dual conception did physically look like.

Two great questions naturally arose: (1) Could this conception empirically be proved at all? And (2): Did our Universe have such a conception? Both questions could be answered positively.

As the coincidence of the Smallest and the Largest was epistemologically still related to the visible side of reality, there had to be a *corresponding empirical coincidence* in our physical Universe, if something transcendent/invisible was supposed of being really existing. This **prediction**, which I am calling »Cusanus' conjecture«, has never been formulated in this clarity. *It is the first physical prediction of a Modern Metaphysics.*

Cusanus itself was very close to this prediction, but he was almost exclusively attached to the One hoping to get a glimpse of its true nature and thereby he left the visible Universe behind. The Universe was simply not the focus of all his thoughts. And everybody followed him on this road missing the great possibility of formulating a meaningful, i.e. scientific, sentence about this very important entity of our reality.[23] Actually until today no thinker has realized this far-reaching possibility.

In his book *Dreams of a Final Theory* the physicist Steven Weinberg describes an elegant code as something by which an impressive result is given with a minimum of unnecessary complication.[24] This description fits perfectly to Cusanus' conjecture: It describes by a theoretically very uncomplicated construct how the most wanted entity, i.e. the One, could be empirically imprinted in the structure of our Universe.

And more than that: It seems, that our Universe does really follow this code sequence. If we look at its outermost edge – the Threshold Area -, we can see that there is an empirical coincidence which remarkably corresponds to the coincidence of the Smallest and the Largest: it is the already mentioned coincidence between the local inertial compass and the frame of the most distant galaxies and quasars.

VIII. Is Cusanus' conjecture empirically realized?

If we look behind the expressions 'local inertial compass' and the 'frame of the most distant galaxies and quasars', then we can see that both physical expressions are *spatially* related to the smallest and the largest scale of our Universe. The physical key term in order to unveil these relations is term of the *inertial frame*. [25]

Smallest: The local inertial compass is directly related to Newton's first »law of inertia« - and this law is, in fact, nothing but a definition of an inertial frame. Although modern physics follows GTR and excludes therefore a global inertial frame, a local inertial frame is still considered of being valid - at least *within an infinitely small region of space*. This conclusion can even be defended by its *equivalence principle* if we do not relate this principle to the field of gravity, but instead to the One. Although this relation is only supposed and not yet discussed here in detail, there is one striking argument for this supposition: *The equivalence principle bases upon a factual coincidence*. Therefore it appears almost unavoidably as a *sub-principle* of the more general principle of radical non-duality. It reveals us to which experimental accuracy an inertial frame is physically realized *in an*

infinitely small region of space. Even the most advanced test could not detect any difference (between the inertial mass and the gravitational mass). If there would be any difference, then it would be less than a few parts in a trillion.

Largest: If we look at the other expression of this coincidence - the frame of the most distant galaxies and quasars -, then we can see that this frame is not only of inertial character, it is even related to the »largest« scale of our Universe.

But this position is not yet verified in the same way like the first one. As the inertial character of the frame of the most distant galaxies and quasars is realized in our Universe only *approximately*, the possibility of a very subtle rotation is not yet excluded. According to the recent (and often favoured) cosmological hypothesis of the inflationary Universe a very subtle rotation is assumed. As the Universe has been expanded exceedingly rapidly in its early phase, any initial rotation has slowed down correspondingly and so the distant objects do appear merely as not-rotating, but in fact a very little rotation is left. The assumed rotation rate varies between 10^{-80} to 10^{-131} radians per year, which is in agreement with experiment. It could be a random error that shrouds a null result. According to informal talks with physicists working on this field the possibility of a non-rotation is not yet excluded by experiment. That means, it could still be possible, that our Universe is of inertial character at its largest scale. And if we look for the degree how the local and the global inertial frame do coincide within our real Universe, then this possibility seems to be quite likely, especially if we appreciate the simplicity of the Principle of Radical Non-Duality, which is discussed in the following chapter.

Coincidence: According to the most recent measurements the local and the global frame coincide to a very high accuracy: to $2,5 \times 10^{-4}$ arcsec in a year.

The conclusion of all these three points is obvious: If the coincidence of the local inertial compass and the frame of the most distant galaxies and quasars would be the empirical counterpart of the coincidence of the Smallest and the Largest, then the One does really exist. As the One represents an unconditioned and all-embracing foundation of the physical Universe, something like a meta-ether, the relativistic paradigm is faced with its greatest challenge.

IX. Mach's Principle vs. Principle of Radical Non-Duality

As the previous chapter may have shown the Principle of Radical Non-Duality is due to Mach's Principle *a very simple explanation* of the coincidence of the inertial compass and the stellar compass. As such it follows the methodological principle, known as *Occam's razor*. According to this principle the simplest explanations tends to be the right one. This principle does play an important role in modern physics.

Although we cannot be sure, whether the Principle of Radical Non-Duality is quite true, but it is certainly a principle to be considered – as Mach's Principle was in the past. It is an interesting alternative to this highly materialistic principle, because it is distinguished by a great conceptual simplicity. But to appreciate the simplicity of this principle, this is not easy, because it sounds totally unbelievable – at least at first sight. But this impression vanishes, if we look at modern physics. Then we will see, that modern physicists are already in close touch with it.

The theoretical physicist Paul Davies f.e. has described Mach's principle (i.e. the coincidence of the inertial and the stellar compass) explicitly *as linking the small and the large*.^[26] The difference between

physics and metaphysics is therefore only *gradual*. Physics is talking about the (very) Small and the (very) Large, whereas metaphysics is talking about the Smallest and the Largest. This difference is quite very little. As far as practical physics is concerned, this difference can even be neglected. It is possible, to do practical physics successfully, without ever thinking of the philosophical and physical questions connected with it.

But as far the *most fundamental foundation of the physical Universe* is concerned, this difference gains a fundamental importance, because only the coincidence of the Largest and Smallest enables us to interpret the coincidence of the inertial and the stellar compass *as the empirical shadow of the One* within our physical Universe. A coincidence of something very Small and very Large does not work. Although this interpretation does not include neither explicitly nor implicitly any *quantitative* proposition, it contradicts already in its unspecified form the spirit of Mach's principle as well as the spirit of relativistic thinking. In the following chapter I like to give a concrete example.

X. Why the inertial frame is fundamental

As metaphysics asserts the existence of a fundamental foundation of the physical Universe, i.e. the One, it represents, in principle, the most fundamental discipline of physics. But this far-reaching claim could not never be retired *in a physical meaningful way*. The most metaphysical theories tended to be extremely general and as such highly unspecific. No specific fact could be predicted to which appeal could be made to show that a metaphysical proposition falls down or not. Thus during its whole history metaphysics was always

far from being an empirical discipline. Out of this total failure to make precise predictions metaphysics is even considered as scientifically meaningless.

As this paper has shown there are by all means facts to which a metaphysics can appeal, but all these facts are only ascertainable, if the *methodological turn* is strictly performed. Otherwise we are trapped in an area, which is by nature of unobservable character. If the existence of a transcendent field of reality is scientifically asserted, then there can be no single fact, which is referred to this field. This possibility is, in principle, excluded. All facts of reality can only be found within the visible or physical Universe.

If we can accept this limit, then metaphysics turns out to be a very powerful and even revolutionary physical discipline. It offers us f.e. the possibility to identify *really fundamental physical terms*. As no foundation could be more fundamental than the One itself all terms which can *directly* be connected with this branch are also of fundamental character. In modern physics we don't know what is really fundamental. We have *no physical criterion*, to recognize something as really fundamental. All we have are feelings. Hence, we are still stumbling through the physical Universe without knowing what is really fundamental.

Though the coincidence of the Smallest and the Largest is only one metaphysical proposition, already this proposition allows us to recognise at least one physical term as a really fundamental notion, because this coincidence is *exclusively* determined by the One and nothing else: It is the term of the *inertial frame*. This term is connected with the Smallest as well as with the Largest. Therefore it is metaphysically distinguished as a *fundamental term* of our physical Universe.

If we do eliminate this term physically, then we cut off a very important root to a deep and penetrating understanding of the

nature of the physical Universe. And relativity is a paradigm, by which just this term should be eliminated *totally*.

Its founder Albert Einstein struggled his whole life *against* this term. Already in his popular book *Relativity: The Special and the General Theory* (1917) he asked for a physical, *i.e.* observable, reason why inertial frame were preferred by Nature. He used a charming metaphor to explain what he found so objectionable about this term: 'Consider two identical teakettles sitting on a stove. One is giving off steam, but the other not. The observer is puzzled by this until realizing that the burner under the first kettle is turned on, but that the burner under the second is not.'

But, as Einstein pointed to, for the preferred character of the inertial frame such an observable reason could not be found. At that time two explanations were physically known: Newton's absolute space and Einstein's spacetime, but neither absolute space nor spacetime could *directly* be observed. Therefore Einstein found both explanations highly unsatisfactory. He looked instead for an observable cause. By implementing Mach's principle into this GTR he tried to explain the existence of the (local) inertial frame by the (observable) masses of fixed stars. If this attempt would have been successful, then the term of the inertial frame would have been eliminated. Almost his whole life Einstein tried to accomplish this task. For him it seemed contrary to the mode of thinking in physics to conceive of thing, like the inertial frame, which acts itself, but which cannot be acted upon. This unconditioned character of the *inertial frame* was a further important reason why he was led to make the attempt to eliminate this term. It was something like an 'epistemological defect' which had to be overcome. But as we know, all his attempts fortunately failed.

In the theoretical framework of a metaphysics the unobservable and the unconditioned character of the inertial frame does not appear as an epistemological defect, but as a natural *epistemological demand*,

because it is directly related to something unconditioned and invisible.

Although Einstein struggled against this term almost his whole life, at the end he does not only concede his failure, he even made a very astonishing statement. In his last lecture, given at the Palmer Physical Laboratory in April 14, 1954, he actually compared the inertial frame with 'God Almighty'. Like him it would be unaffected by anything else.[27] In this lecture he also explained why the implementation of Mach's principle into his GTR failed. "If you give up space, you have an enormous number of distances, and unhandy consistency relations." [28]

And in fact, if the coincidence of the inertial compass and the stellar compass shall be explained in a purely relational manner, then we have to stretch a complete and consistent chain of material interactions over the whole Universe – from the very Small to the very Large. Einstein was obviously well aware of the difficulty and the hopelessness of this task. It shows clearly, why the 'Principle of Radical Non-Duality', i.e. the metaphysical explanation, can claim of being a far more simple explanation than 'Mach's Principle'.

To make the picture about Einstein more balanced, it is quite fair, to call the attention to other theoretical ways that Einstein also adopted, at various times, of implementing Mach's Principle. These other ways are not widely known.

An example is given: As Einstein discovered that his GTR did not satisfy Mach's principle, he actually intended to overcome this problem by implementing »boundary conditions at infinity« in his theory.

If we consider the Principle of Radical Non-Duality, then we can see that it represents, technically spoken, nothing else than a »boundary condition at infinity«. As such it states, that the Universe has to be infinite and Euclidean at infinity, because the term of the inertial frame is implicitly suggesting the validity of the Euclidean geometry.

The geometrical term 'straight line' is inseparably connected with the term of the 'inertial frame'. And as the 'inertial frame' is metaphysically related to the largest scale of the Universe, i.e. to a scale of infinitely large extension, we have consequently to assume an Euclidean geometry at infinity.

As Albert Einstein was faced with the absolute (non-relational) aspect of his GTR he contemplated exactly about such conditions. But already in 1922 he rejected these conditions.

"The hypothesis that the universe is infinite and Euclidean at infinity, is, from the relativistic point of view, a complicated hypothesis. In the language of the general theory of relativity it demands that the Riemann tensor of the fourth rank, R_{iklm} , shall vanish at infinity, which furnishes twenty independent conditions, while only ten curvature components, $R_{\mu\nu}$, enter into the laws of the gravitational field. It is certainly unsatisfactory to postulated such a far-reaching limitation without any physical basis for it." [29]

Modern physicists are still looking for such a physical basis, because boundary conditions at infinity turned out to be necessary in order to specify a solution of the field equations of general relativity, but they were not contained in the theory. They had instead to be added from outside as an *extra and artificial hypotheses*. The physical founding of the boundary conditions is still an unsolved problem of modern physics. How physicists are dealing with this problem depends, as the physicist Hubert F.M. Goenner states, on whether their belief in Einstein's general relativity is *stronger* than their belief in Mach's Principle [i.e. the coincidence of the inertial compass and the stellar compass] or vice versa. In the first case, Mach's Principle is discredited and thrown out of the window as Einstein has done later in his life. In the second case, usually, scientists develop alternative theories which they expect to reflect better their particular formulation of Mach's Principle.[30]

In this paper the second case is given. As it has shown, a modern metaphysics provides an alternative theoretical approach. It differs, as the discussion of the term 'inertial frame' has documented, fundamentally from GTR. According to this approach the boundary conditions are not the result of an *internal cause* of the visible Universe, i.e. of the global distribution of matter, but the result of an *external cause*, i.e. of the One. Although the meta-physical explanation, given by the Principle of Radical Non-Duality, is far more simple and transparent than the common physical explanation, given by the Mach's Principle, which could never be formulated in a clear fashion, the price of this simplicity and transparency is immense: We have to accept a new physical foundation of the Universe, which is over and above completely invisible and as such out of every scientific reach.

Therefore it will need a lot of time and a lot of work, to accept such a foundation as the ultimate basis of our physical Universe. As far as the work is concerned, we have f.e. to formulate metaphysical propositions not only qualitatively but also *quantitatively*. In the next chapter it is shown how we can do that.

XI. The *elementary matrix* of a Modern Metaphysics

The terms of the Smallest and Largest are only *qualitative* terms. But their quantitative character becomes quite obvious, as we reformulate them as the »infinite Small« and the »infinite Large«. Hence, it would be a natural move to choose for these terms *the quantitative values of $R = 0$ and $R = \infty$* . [31]

Already this formalization reveals that metaphysics has formally well defined physical consequences. If we suppose the notion of $R =$

∞ as being a true metaphysical statement, then our Universe cannot be finite: *It has to be infinite.*

But this pair is only of *exemplary* character. If the One is really the fundamental foundation of our physical Universe, then there have to be further pairs, because for the description of the physical Universe spatial terms are surely not enough. Just this mandatory demand is the true revolutionary moment of a modern metaphysics, because in modern physics infinite values are often rejected as *unphysical*. The term of the *velocity* is a typical example.

The velocity of $v = \infty$ is not part of our contemporary physics. It is rejected by the Special Theory of Relativity (STR) as unphysical. Instead the finite value of the light $v = c$ is assumed. The speed of light is regarded as the ultimate speed limit of our Universe. But if we have trust in the existence of the One, or the Meta-Ether, then we have unavoidably to assert the velocity of $v = \infty$ as *somehow* meaningful.

This assertion is consistent with the metaphysical property of omnipresence. If an acting force shall be omnipresent, it has to connect two spatially separated points of the Universe *instantaneously*. As STR does exclude this possibility, the conclusion of this metaphysical demand is clear: If our Universe bases really upon something omnipresent, like the One, then Einstein's theory does not provide a complete picture of the Universe. It must be somehow *incomplete*, because the metaphysically demanded velocity-section between c and ∞ is not taken into account.

Trusting the beauty and the simplicity of the metaphysical approach I have searched for this complete picture. It led me to the discovery of the archetypal structure of the *Mandala*. This archetypal structure shows as conceived by me how space and time have to be structured, if the existence of the One is assumed. In this metaphysically completed picture of the Universe the relativistic speed limit of $v = c$ is substituted by speed limit of $v = \infty$. In the paper *Do space and time*

have an archetypal Design? an overview of this metaphysical picture is given. This archetypal picture is not only distinguished by symmetry and beauty, it does not abandon or even abolish STR. Instead it distinguishes the relativistic spacetime as a picture, which is perfectly embedded into the metaphysical one.[32]

If we summarize the formalization of these two physical quantities (R, v) it is near at hand to suppose further formal pairs of 0 and ∞ , f.e. a pair for the energy content of our Universe (E). In the following table this supposition is shown.

	Minimum	Maximum
R	0	∞
<i>v</i>	0	∞
E	0	∞
?	0	∞

As the previous example - the discovery of the structure of the Mandala - has shown this *elementary matrix* rewrites the essential task of the research program of a modern metaphysics. If we like to find out, how the One has determined the structure of the physical Universe we have *to identify, to complete or even to develop* physical theories which do satisfy the formal demands of this matrix.

As the presented piece of metaphysics bases upon a very small and fragile scientific foundation, it may still be doubted that a modern metaphysics does have any physical meaning, but if this old-fashioned discipline should ever reach the status of a physical discipline like atomic physics, it would not only change our view of the physical Universe, it would also change our view of spirituality, especially our view of GOD.

The Lord God is subtle, but He is not malicious.
Albert Einstein

XII. Theological implications of a Modern Metaphysics

Nicolaus Cusanus was not only a philosopher, but he was also a close member of the Catholic Church. Actually he was a Cardinal, friend of two popes and at the end of his life he advanced even to the highest position of the Catholic Church (besides of being a pope) – to vicar general in Rome.

The fact, that the Principle of Radical Non-Duality bases essentially upon a theoretical construct of such an origin suggests, of course, that the existence of God should be proved, *but this is in fact not the case*. If we look at the traditional picture of God, this fact becomes quite clear.

God is usually considered as *a supreme being*. Therefore invisibility of God is implicitly considered as the result of *a special kind of personal action*. But if we consider invisibility as the final result of a specific conception of the physical Universe, i.e. as the result of a radical non-dual conception, then our traditional picture of God is scientifically challenged, because it is replaced by a completely impersonal cause.[33]

The access to this transcendent field of reality, the One, would no longer depend on a membership of a special belief. Instead of that the One would be open to everybody and everywhere. This theological implication would challenge all three monotheistic religions, because each of them claims of having the ultimate truth about the transcendent realm of reality.

Though a modern metaphysics may have very far-reaching theological implications, it is nothing more than a scientific program.

It tries to continue a process of scientific inquiry which started in the 17th century and is historically called Enlightenment.

In this process science played the most important role. Science has enlightened almost all fields of reality, especially the laws of matter and the secret language of life. But in spite of this enormous success, one field of reality remained yet unenlightened: It is the existence of the One or, in other terms, of the transcendent field of reality. Until today we don't have any scientific knowledge about this part of reality. It is a great paradox of our time, that the behaviour of most human beings is highly determined by this field of reality, but that we do not have any serious and rational information about it. All knowledge we have comes from a time which is much older than natural science and natural philosophy.

This circumstance has affected Western culture tremendously. During the last four hundred years of constant scientific progress it has undermined spirituality and caused often feelings of senselessness, irrationalism and dogmatism.

Perhaps a modern metaphysics could heal this break within our culture by presenting an enlightened spirituality *beyond irrational and dogmatic positions*. The physicist Albert Einstein has formulated this kind of spirituality in the most brilliant way: "Even though the realms of religion and science in themselves are clearly marked off from each other, nevertheless there exist between the two strong reciprocal relationships and dependencies. Though religion may be that which determines the goal, it has, nevertheless, learned from science, in the broadest sense, what means will contribute to the attainment of the goals it has set up. But science can only be created by those who are thoroughly imbued with the aspiration toward truth and understanding. This source of feeling, however, springs from the sphere of religion. To this there also belongs the faith in the possibility that the regulations valid for the world of existence are rational, that is, comprehensible to reason. I cannot conceive of a

genuine scientist without that profound faith. The situation may be expressed by an image: science without religion is lame, religion without science is blind.”[34]

If we develop a modern metaphysics, we can bring science, especially physics, to a state far beyond the present ‘lame’ state. We can make, as I already mentioned, new and astonishing scientific discoveries. But we can even protect religion of becoming blind, because science can never be dogmatic, because its methodological attitude does forbid it. Scientifically we can never say: *This is certain*. If we study the real world we can never come to an end and say: That’s all about! We can never be sure that sometime in the future a little fact comes up that tells us: Reality is completely different!

But religion is also of great importance as far as science is concerned: If we connect it with science, we are protected against pure materialism, because science tends to conclude that the material world is all that exists. Mach’s Principle is certainly the most striking example of this tendency. And just this purely materialistic view of the universe leads as we see today to an unrestrained capitalism. Actually we are not threatened by religious fundamentalism alone, we are also threatened by this kind of materialism.

Briefly, if science and religion are working together, connected by a modern metaphysics, we can possibly get the best of both disciplines. We are able to enrich the human race at all levels, materially as well as spiritually.

References

- [1] Pfister, Herbert; *Dragging Effects Near Rotating Bodies and in Cosmological Models* in: Barbour, Julien; Pfister, Herbert (ed.), *Machs Principle*, 1995, p. 325.
- [2] in: Friedrich Hund, *Grundbegriffe der Physik*, Mannheim, 1979, S.42
- [3] Mach, Ernst, *The Science of Mechanics*, first published in 1883.
- [4] Einstein, Albert (1918), pp. 241, 242
- [5] d'Inverno, Ray, *Introducing Einstein's Relativity*, Oxford, 1992, p.123
- [6] In contemporary physics there are only very few other approaches. The physicist R. Michael Jones has given an explanation which bases upon *quantum cosmology*, especially upon a straightforward application of semi-classical approximations to quantum cosmology. The title of his paper: *The classical action for a Bianchi V I model*, published in: gr-qc/9903079, March 18, 1999.
- [7] Pfister, Herbert; *Dragging Effects Near Rotating Bodies and in Cosmological Models* in: Barbour, Julien; Pfister, Herbert (ed.), *Machs Principle*, 1995, p. 325.
- [8] Pfister, Herbert; *Newton's First Law Revisited* in: *Foundation of Physics Letters*, Vol. 17, No. 1, February 2004.
- [9] Davies, Paul, *Superforce*, N.Y. 1984, p. 209 (Mach's principle: linking the large and the small)
- [10] Thuan, Trinh Xuan, *The secret melody*, New York 1995, p. 272
- [11] Hund, Friedrich, *Grundbegriffe der Physik*, Mannheim 1979, p. 42
- [12] d'Inverno, Ray, *Introducing Einstein's relativity*, Oxford 1992, p. 123
- [13] *General Discussion: What is the Machian Program?* in: Barbour, Julien; Pfister, Herbert (ed.), *Machs Principle*, 1995, p. 93
- [14] McCrea, W.H., *Doubts about Mach's Principle*, *Nature* Vol. 230, March 12, 1971, pp. 95 - 97
- The main argument of McCrea's position is that, if we look at a very remote object, we look in a fixed direction. If we are at O and A, B are any two adjacent objects in the sky, then because the relative speed of mutual separation or approach of A and B cannot exceed the speed of light c , the rate of change of the angle AOB becomes as small as we please simply by taking the distances OA, OB to be sufficiently great. Therefore, so far as directions are concerned, we obtain a rigid frame of reference simply by looking at very distant objects.
- [15] d'Inverno, Ray, *Introducing Einstein's relativity*, Oxford 1992, p. 123
- [16] Compare: Thuan, Trinh Xuan, *The secret melody*, New York 1995, p. 271, 272 (Foucault's Pendulum)
- [17] The physicist H. Pfister has listed different sources: For laboratory-size inertial systems, realised, e.g., by laser gyroscopes, this coincidence is presently tested with an accuracy of 10^{-8} of the earth's rotation (1), for terrestrial reference systems, realised, e.g. by VLBI and GPS, the accuracy is 10^{-9} of the earth's rotation. (2) For the dynamical solar reference the accuracy amounts to 0.02 milliarcsec/year (2). For the galactic reference frame realised by the Hipparcos catalogue, it amounts to 0.25 milliarcsec/year (3). According to Pfister measurement (3) can possibly be improved by a factor 200 through the planned GAIA mission.
- (1) G.E. Stedman, "Ring-laser tests of fundamental physics and geophysics", *Rep. Prof. Phys.* 60, 615 - 688, R.W. Dunn et al., "Design and initial

-
- operation of a 367-m2 rectangular ring laser", *App. Optics* 41, 1685 - 1688 (2002)
- (2) J. Kovalevsky, I.I. Mueller, and B. Kolaczek, eds., *Reference Frames in Astronomy and Geophysics* (Kluwer Academic, Dordrecht, 1989)
- (3) J. Kovalevsky et al. "The Hipparcos catalogue as a realisation of the extragalactic reference frame", *Astron. Astrophys.* 323, 620-633 (1997)
- in: Pfister, Herbert; *Newton's First Law Revisited* in: *Foundation of Physics Letters*, Vol. 17, No. 1, February 2004, p. 62-64.
- [18] Huxley, Aldous, *The Perennial Philosophy*, 1990
- [19] Yamaiki, Kazuhiko, *Nicholas of Cusa: A Medieval Thinker for the Modern Age*, 2002. It is a collection of essays presented as the first congress on Cusanus held to be in Asia. The title of this conference: *Cusanus Standing at the Threshold*.
- [20] Cusanus, Nicholas; *De Docta Ignorantia*, I, 4, 1440; On Learned Ignorance, translated by Jasper Hopkins 1985.
- [21] In physics we would probably talk about *extremal states*.
- [22] In the German text of the *De Docta Ignorantia* this translation is even *explicitly* given. Minimum is translated as 'das Größte' (the Largest) and Minimum is translated as 'das Kleinste' (the Smallest).
- [23] „...everything measurable falls between the maximum and the minimum.“ in: Cusanus, Nicholas; *De Docta Ignorantia*, 1, 16 - 17 - This includes, of course, the notions of the Smallest and the Largest as well. But Cusanus have never recognised that his doctrine could be key to prove the existence of the One in an empirical way.
- [24] Weinberg, Steven, *Dreams of a Final Theory*, N.Y. 1993. (I have used the German version: *Der Traum von der Einheit des Universums*, München 1993, S. 141)
- [25] In my German book *Elementarmatrix 3.0 – Auf der Suche nach dem Einen* (*Elementarmatrix 3.0 – On Serach for the One*), Hamburg 2000, it is documented how this term of the inertial frame was discovered as a metaphysical key term.
- [26] Davies, Paul, *Superforce*, N.Y. 1984, p. 209 (Mach's principle: linking the large and the small)
- [27] Last Lecture of Albert Einstein in: *Albert Einstein, His influence on Physics, Philosophy and Politics*, ed. by Peter C. Aichelburg and Roman U. Sexl, Braunschweig 1979, p. 208
- [28] *ib.* p. 209
- [29] Einstein, Albert in: *The Meaning of Relativity*, Princeton, New Jersey 1955, p. 99, 100. The first edition of this book was already published in 1922. It bases on some lectures that Einstein gave at Princeton University in Mai 1921. Einstein's struggle with such boundary conditions at infinity is historically highlighted in the paper *Einstein's Formulation of Mach's Principle* by Carl Hofer in: Barbour, Julien; Pfister, Herbert (ed.), *Machs Principle*, 1995, p. 65 - 90
- [30] Goenner, Hubert F. M., *Mach's Principle and Theories of Gravitation*. in: Barbour, Julien; Pfister, Herbert (ed.), *Machs Principle*, 1995, p. 443, 444
- [31] R means *Radius of the Universe*.
- [32] see: Newsletter of the NPA, Volume 13, Number 2, July 2007, p. 9
- [33] In my German book *Über Entdeckung Gottes am Rande des Universums* (*About the Discovery of God at the Edge of our Universe*), Petersberg 2005, these theological implications are investigated in detail.

[34] Albert Einstein, *Out of My Later Years* (1956)