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The Higgs Boson, The God Particle, and the Correlation Between Scientific and Religious Narratives

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Abstract: The Higgs mechanism – as part of the Standard Model of Elementary Particle Physics – is mostly considered to be a real physical process that brings about the mass of every elementary particle. Recent discussions show that there are alternative interpretations of it, differing from the common one in the spectrum and the features of some specific physical objects. This, in turn, shows that the problem of reference remains unsolved for physical theories: It is not obvious what kind of objects theoretical terms exactly refer to. Given the fact that the reference to the object level is ambiguous even in the natural sciences, what correlations can be established between scientific terms and religious expressions at all? Do ontic ambiguities make the dialogue between science and religion easier or more complicated? This article reflects on these questions by examining the possible significations (and interrelations) of scientific and religious signs in general as well as from the perspective of the individual. I suggest that religious storytelling and ritual practices can establish specific associations between scientific and religious world-views under certain conditions – without confusing the different world-views conceptually.

Keywords: Higgs mechanism, semiotics, category mistake, metaphor, ritual.

The Higgs Mechanism: Basic Terms and Concepts

Before the Higgs boson was discovered in 2012 at the CERN laboratories (Geneva),[1] there had already been some controversial discussions about the ontic interpretation of the so-called “Higgs mechanism”, which is part of the Standard Model of Elementary Particle Physics. Physics textbooks and popular science magazines provide a standard interpretation of this mechanism, yet this interpretation is questioned by contemporary philosophy of science as well as by several physicists. Some scientists even bet that the Higgs boson would never be found, because it would not exist; others countered and bet on the opposite.

Did the results from the experiments at the Large Hadron Collider (CERN) in 2012 decide the winner of the bet? The answer is “yes”, as long as we stick to the question of the existence of the Higgs *boson*. However, the discussion about the interpretation of the Higgs *mechanism* goes on. Before I revisit the different positions on this, I need to explain some basics of the Standard Model of Elementary Particle Physics and the Higgs mechanism in general.

1 First publications about the discovery of the Higgs boson: CMS Collaboration, “Observation of a new boson at a mass of 125 GeV with the CMS experiment at the LHC”. ATLAS Collaboration, “Observation of a New Particle in the Search for the Standard Model Higgs Boson with the ATLAS Detector at the LHC”.

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From the public press we learn that the Higgs mechanism is the way in which elementary particles gain mass, or to be more specific, "bare mass".[2] The CERN press office claims:

> [O]ur understanding of nature is incomplete. In particular, the Standard Model cannot answer one basic question: Why do most of these elementary particles have masses? [...] Several physicists, including Peter Higgs, discovered a mechanism that, if added to the equations, would allow particles to have masses. [...] According to the theory, the Higgs mechanism works as a medium that exists everywhere in space. Particles gain mass by interacting with this medium.[3]

If I had not studied physics, I might not understand the question of *why* most of the elementary particles have masses. Why is this a basic question and why is this question asked at all? When I was young, I just took it for granted that (most) particles already have mass and that's it!

The answer lies within the structures of contemporary elementary particle theories. These theories are inspired by quantum electrodynamics, which results from the field quantization of classical electrodynamics. Quantum electrodynamics is the quantum theory of electromagnetic fields and electrically charged particles. It is empirically tested on the highest degree of precision compared to all physical theories we know of.

There is a leading principle that applies to the theory of classical electrodynamics, called "gauge symmetry". This principle dictates that certain mathematical functions can be added to the electromagnetic potentials without changing the measurable parameters – also called the *observables* – of the theory. Thus, one can execute certain changes (transformations) to the basic equations of the theory without any influence on the real physical processes described by the theory. Everything that can be measured about electrodynamics (especially the field strengths) is invariant against gauge transformations.

According to a famous theorem by Emmy Noether,[4] any continuous symmetry of a physical theory constitutes a conservation law. The basic equations of classical mechanics, for instance, are symmetric according to global shifts in space. This leads to general momentum conservation. The gauge symmetry of classical electrodynamics is associated with the conservation of electrical charge.

Quantum electrodynamics features an extended form of gauge symmetry compared to classical electrodynamics. Not only the potentials of the electromagnetic fields can be subject to gauge transformations, but also particles like electrons, protons, etc., – i.e., particles having a half-integral spin (which is a specific observable in quantum physics). These particles are called "fermions". In quantum electrodynamics, the gauge symmetry is linked to charge conservation, too, but it is also associated with the interaction between the electromagnetic fields and the fermions.

Quantum electrodynamics serves as a paradigm for constructing modern elementary particle theories. However, in order to describe the so-called *weak particle interactions*, which are associated e.g. with the radioactive β-decay, one has to go beyond quantum electrodynamics, because these interactions are of a non-electromagnetic nature. Nonetheless, theories describing weak interactions should be aligned to the leading principles of quantum electrodynamics. Only in this case a common theory can be obtained that covers both electromagnetic and weak interactions. (The combination of both is also known as "the *electroweak* interactions".) Thus, weak interactions should satisfy gauge symmetry, too, albeit a sort of gauge symmetry that is different from the electromagnetic one. The reason is quite simple: the gauge symmetry of electromagnetic interactions is associated with the conservation of the electric charge, whereas the gauge symmetry of weak interactions is interlinked with a different quantum number, which is called the *weak isospin*.[5]

Mathematically it turns out that the force fields of a gauge theory – so-called "gauge fields" – have to be massless; otherwise the gauge symmetry would break down. On the other hand, it is empirically known that the weak forces take effect on very short distances only. (That is the reason for being *weak*.) It can be calculated quite easily that short-range force fields have to be massive. Well, that is a dilemma:

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2 The *bare mass* is the mass of a particle within its own reference system, i.e. its mass at zero velocity. Some particles like the photon cannot have a zero velocity. In this case, the bare mass itself is zero.

3 CERN press office, "The Higgs boson".

4 Noether, "Invariante Variationsprobleme", 235 et seq.

5 To be more precise, the electroweak interactions have two conserved quantum numbers, i.e. (one component of) the weak isospin and the weak hypercharge, instead of the single conserved electrical charge of electromagnetic interactions.

1. The forces of weak interactions must be transmitted by *fields that have (bare) masses*.
2. The fields that transmit weak interaction forces *must be massless*, because otherwise they would violate the gauge symmetry.

At first glance, there seems to be no way out of this dilemma – but there is. It is called “spontaneous symmetry breaking” and it is implemented in the Standard Model of Elementary Particle Physics by means of the Higgs mechanism. This technique allows the possibility for massive gauge fields to exist with proper weak isospin conservation.

Let me try to outline the basic idea of the Higgs mechanism without presenting any of the corresponding mathematical formulae involved.

The first step to understand the concept of this mechanism is to recognise that any electromagnetic wave of a specific wavelength – and this includes monochromatic light – is polarized, as is every single photon. A photon is the quantum-physical equivalent of the electromagnetic wave. The polarization of a photon provides the information about the direction and behaviour of its field forces or “field vectors”. The direction of the electric and magnetic forces of a photon is always vertical to its direction of motion. Thus, the photon has two polarization degrees of freedom, which are due to the two directions in space, which define the polarization plane (so-called “transversal polarization”). This fact is intrinsically linked to the masslessness of the photon.

For massive field forces, the situation is different. They have a third degree of freedom concerning their polarization. That is, the field forces can have a component in the propagation direction of the wave (“longitudinal polarization”). In sum:

1. Fields that respect gauge symmetry have two polarization degrees of freedom vertical to the direction of propagation (these fields do not have mass).
2. Fields that have three degrees of freedom concerning their polarization violate gauge symmetry (because these particles are massive).

This holds for fields with a spin quantum number of “1” (spin-1-bosons or “vector bosons”).

The longitudinal polarization degree of freedom behaves like a spin-0-boson[6] towards certain mathematical transformations (like rotations in space). This gives rise to the following idea: What if we manage to describe the longitudinal polarization in a way that “decouples” it from the spin-1-boson and “attaches” it to an additional spin-0-boson? Would it be possible to put it to the theory with the outcome that there is some kind of a combination of a spin-0-boson and a spin-1-boson, both without any mass at all? Can we preserve gauge symmetry in this way, because then there would be only massless particles in the theory? (However, these massless particles should behave as if they were massive.)

At first, this sounds like a simple ad hoc reinterpretation of mathematical terms in order to save the theoretical approach without changing the theory. In fact, it is not so easy, but the Higgs mechanism fulfils the needs in a similar but somewhat more complicated manner. In the framework of the Higgs mechanism, the four vector bosons of electroweak interactions originally have no mass, but they couple to a two-component, complex scalar field, the famous so-called *Higgs field*. Its parameterisation ensures that one of its components – the uncharged component – does not disappear in the ground state, i.e. in the physical vacuum. (On the contrary, all other particles do.) Physicists call this the non-vanishing “vacuum expectation value” (VEV) of the Higgs field. The fixed non-zero VEV implies that the neutral component of the Higgs field is present everywhere in space and always available to be coupled to the fields of electroweak forces. The implementation of the Higgs mechanism into the theory of electroweak interactions has the following effects:

1. There are couplings between vector bosons and the non-zero VEV of the Higgs field. Since the Higgs-VEV appears as a fixed constant value in the basic equations of the theory, the coupling terms do not look like couplings between two particles anymore, but like mass terms of the vector bosons.
2. The two complex components of the Higgs field have four real degrees of freedom altogether. Three of

6 A spin-0-boson is a field without any spin quantum number, also called “scalar field”.

them are “eaten” by one vector boson each, i.e., each of the three vector bosons gets one additional degree of freedom of “spin-0-type”. As we have seen before, the degree of freedom of a spin-0-boson corresponds to a longitudinal polarization degree of freedom.
3. Now there has been one degree of freedom and one vector boson left over (of four). The latter one does not couple to the Higgs field and gets neither a mass term nor a longitudinal polarization. The degree of freedom left over appears as an actual, physical spin-0-boson, the *Higgs boson*. The Higgs boson gains a mass term by coupling to the VEV of the Higgs field itself.

As a result, electroweak interactions are realized by four vector bosons, three of them are massive and one of them has no mass. The latter one is simply the massless photon, which transmits the electromagnetic force. The other three vector bosons have mass and thus the weak forces take effect on short distances only. As required, the massive vector bosons have longitudinal polarization degrees of freedom.

Is the gauge symmetry preserved in this scenario? Yes, the full theory is gauge invariant, but only the ground state (with the non-vanishing VEV) of the Higgs field is not. However, the ground state does not affect the general rules of dynamics, whereas the conservation laws rely on the dynamics of the system. In this sense, the Higgs mechanism provides the required result: a gauge theory that contains massive interaction fields. It is based on the same construction principles as the very successful quantum electrodynamics, and it includes this as a sub-theory.

How can the theory now be gauge invariant, even if it includes massive vector bosons? Let us focus on the three degrees of freedom of the Higgs field that are “eaten” by the vector bosons. These degrees of freedom can be “picked up” by the vector bosons, solely because *the vector bosons couple to the Higgs field in a gauge invariant way*. On the other hand, the degrees of freedom are intrinsically connected to the longitudinal polarization of the vector bosons. In the context of the Higgs mechanism, the longitudinal polarization degrees of freedom actually represent the gauge symmetry of the full theory for this reason. Thus, the longitudinal polarization (and the masses) of the vector bosons and the concept of gauge invariance do not contradict each other in this respect.

Interpretations of the Higgs Mechanism and Levels of Knowledge in Physics

The non-zero VEV of the Higgs field gives rise to the following interpretation of the Higgs mechanism: The Higgs field is present everywhere in the universe. Whenever a weak vector boson appears in space, it will immediately interact with the Higgs field and gain mass from this interaction. (This holds for several other particles, too.) In other words, this interpretation posits an omnipresent entity, the Higgs field. This entity provides the initial transient with mass. Thus, it serves as the origin of the world’s materiality and persistency. Going beyond the Standard Model of Elementary Particle Physics (SM), physical cosmology today tells a complete history of the universe, claiming to know exactly when the Higgs VEV first came into existence and how it prepared the world’s blueprint to be ready for hosting living creatures and everything else.

Where can this omnipresent field be seen or how can it be measured? The problem is that it cannot be measured directly, because it has already been “eaten” by the particles that gain mass from it (similar to the degrees of freedom that are interlinked with the longitudinal polarization modes). The observable manifestations of the Higgs field are exclusively the following:
1. The masses of the vector bosons and of several other elementary particles.
2. The longitudinal polarization modes of the weak vector bosons.
3. The existence and the mass of the Higgs *boson*.

Based on these measurable quantities and the basic equations of the SM, a different interpretation of the Higgs mechanism would be possible. Instead of claiming that particles are virtually massless, but interact with a magic background field that gives mass to them, one may even state that particles simply *have* masses. It is an intrinsic attribute of the particles in the same way as the longitudinal polarization degrees of freedom are intrinsic attributes of vector bosons. They belong to the particles, but the Higgs field does not exist as an independent entity in nature at all, except for the Higgs *boson*. Thus, we may end up with two different ontic interpretations of this mechanism:

1. The Higgs field is an omnipresent physical entity that interacts with massless particles that gain mass and certain polarization modes from this interaction.
2. There is no permanent Higgs field in space; masses and longitudinal polarizations belong intrinsically to the physical particles. However, in order to get the conservation laws and the dynamics of the particle interactions right, the introduction of the Higgs boson is needed. The particle zoo is enriched by this very special particle and, indeed, it has already been found at the Large Hadron Collider.

These two interpretations are equivalent as long as we refer to the SM and its observables. What we call a particle, a physical object or entity, is not fully determined by the mathematical theory, but requires an additional interpretation. We know from the theory what observables are, but it tells us only ambiguously what physical objects are. On the other hand, we need to have an idea about the physical objects in order to prepare experiments for empirical theory testing.

"Does the Higgs mechanism exist?" asks Holger Lyre.[7] He explicitly states that this question does not affect the (other) question about the existence of the Higgs *boson*, but challenges the explanatory power of the Higgs *mechanism*. He had expressed his doubts about the standard interpretation of the Higgs mechanism even before the Higgs boson was detected, but he argued carefully enough to take a detection of the Higgs boson into consideration. Others countered Lyre by arguing that the Higgs mechanism is a real physical process.[8] Ted Peters and Carl Peterson even see the detection of the Higgs boson as a proof of critical realism. They interpret the Higgs mechanism realistically and draw the conclusion that we can indeed investigate the nature of things we even cannot observe directly – albeit with a residual uncertainty about the "real thing".[9]

The Higgs mechanism of the SM is a very good illustration of the different aspects that link the theory to the empirical world. I want to sketch out them in this way:

1. On the level of the mathematical terms, the *theory* determines the observables, the relations between them, and the dynamics of physical systems.
2. An *interpretation* of a theory determines the classes or types of objects that are addressed by the theory. The interpretation tells us what a physical entity is and what attributes it has. From the example of the Higgs mechanism we can learn that different interpretations may be justified even for the same theory. The classification scheme of physical objects is not (necessarily) unique.
3. This interpretation is the basis for designing experiments and for the *preparation*, i.e. the supply, of concrete sets of physical objects in order to test physical hypothesises empirically.
4. The *observables*, as determined by the theory, are the basis for the finally measured values in the experiment.
5. However, the *measured values* of the experiment and the observables defined by the theory have to be matched against each other. Typically, this is managed with recourse to the interpretation of the theory, because measurements are arranged with respect to the preparation of material objects according to the description of object types given by the interpretation.

What we can measure and what we will measure in a physical experiment therefore depends – amongst other factors – on the theory (and probably its interpretation) that we take as the basis for measurements.

Similarly, the experience of the external world – of its objects and facts – somehow depends on the theoretical descriptions of it. If I touch a bare wire or put my fingers into a socket, I will experience what electric charge or current is. However, "charge" or "current" are entities, or rather attributes of entities,

7 Lyre, "Does the Higgs Mechanism Exist?".
8 Wüthrich, "Eating Goldstone bosons in a phase transition".
9 Peters, Peterson, "The Higgs Boson: An Adventure in Critical Realism".

which are already described by theories and interpretations or, generally speaking, by the sign systems we use.

In order to study the impact of different sign systems on human experience, I want to take advantage of the semiotic theory of Charles Sanders Peirce. Peirce combines his theory of signs with a suitable system of categories. Therefore, his semiotics serves as an interesting tool for further investigations because it is already part of a comprehensive epistemology.

Aspects of Semiotics and Their Relevance to Science and Religion

According to Immanuel Kant, *categories* are principles that synthesize a variety of sensory impressions into a single perception.[10] Although Peirce's table of categories is completely different from Kant's, categories serve as the universal foundation of human cognition even in the context of Peirce's phenomenology. Peirce indicates only three different categories, which he calls "firstness", "secondness" and "thirdness". In his „Syllabus of Certain Topics of Logic", he posits the following definition:

> *Firstness* is that which is such as it is positively and regardless of anything else. *Secondness* is that which is as it is in a *second* something's being as it is, regardless of any third. *Thirdness* is that whose being consists in its bringing about a secondness.[11]

Of course, this is a quite formal definition, which requires further explanation.

"Thirdness" establishes experiences conveyed by symbols, concepts, complex specifications and so on.

> [...] wherever there is thought there is Thirdness. It is genuine Thirdness that gives thought its characteristic.[12]

> The object of experience as a reality is a second. But the desire in seeking to attach the one to the other [e.g. in the course of assembling an artefact according to an idea or plan, LOS] is a third, or medium.[13]

On the level of "secondness", the individual faces the "hard facts". This is the level of the interaction of the ego and the non-ego, the confrontation of a person with the external world, sometimes called "the outward clash".[14]

> We talk of *hard* facts. The hardness, that compulsiveness of experience, is Secondness. [...] All consciousness, all being awake, consists in a sense of reaction between *ego* and *non-ego*.[15]

"Firstness" characterizes something like a pure impression with no relation to anything at all.

> The idea of the absolutely First must be entirely separated from all conception of or reference to anything else.[16] It is mere a sense of quality. It is the sort of element that makes *red* to be such as it is, whatever anything else may be.[17]

These categories can be identified with the different levels of physical theories and their empirical verification as follows: mathematical formalism and the interpretation of a physical theory, i.e. its "objectification", are linked to the category of thirdness. Objectification means definition and description of entities that we face as "things" or objects in the material world. Naturally, objects are the counterparts of the (transcendental) subject. Objects counter subjectivity with "hard facts" (i.e. secondness). They are the objection to the subject.

10 Kant, „Kritik der reinen Vernunft", B 145.
11 Peirce, "Syllabus", 267.
12 Ibid., 269.
13 Peirce, "Phenomenology", CP 1.342.
14 Nagl, *Charles Sanders Peirce*, 94 et seq.
15 Peirce, "Syllabus", 268.
16 Peirce, "A Guess at the Riddle", 248.
17 Peirce, "To William James", CP 8.267.

It is thirdness that generates secondness from the symbolic denotation of something, because in this way it enables the subject to recognize something *as something* – that is the relation between the transcendental subject and the *object of cognition*. This in turn is the basis for any kind of *objective cognition*. As a result, our symbol systems, methods, and tools – that is, our signs and codes – directly influence the identification and experience of the things around us.

The physical analogue of firstness would be something like a measurement value that is by no means related to any theory, measurement quantity, measurement system, or environing laboratory. Of course, nobody would be able to imagine this. Physics cannot interpret such a "stand-alone" measurement value, and as a result, firstness does not seem to play any role in physics. On the contrary, there is a strong correlation between firstness and the observables in physics, because observables indicate the basic conditions of sense perception – embedded in a physical theory.

In summary, we can map Peirce's categories on the following characteristics of physical knowledge:

1. Firstness is the category of pure qualities. Pure qualities do not reference objects, nor do they come under the regime of the self-conscious subject. Whatever belongs to this category will be a precondition of sense perception. It is not yet a perception, but rather a fuzzy sensation and precursor of a perception. It is a latent experience.
2. Secondness is resistance to the existence and force of experience. Physical objects prepared for experiments and actual measurement results are linked to secondness insofar as they are involved in the direct confrontation between the individual and the objective world.
3. The methods of abstraction and cognition, the descriptions of classes of objects, i.e. the physical entities, the definitions of measurement quantities (observables), and the universal relationships between them belong to thirdness. Thirdness enables us to recognize something *as something*.

We will benefit from Peirce's system of categories mainly after performing the next step: the "semiotization" of the empirical method of natural sciences as well as of religious narrations and practices.

According to Peirce, a *sign* is characterized by a triadic relation, which links it (the sign) to an *object* mediated by an *interpretant*. This concept of signs is based on the heuristic idea that a sign does not denote an object in a finally fixed manner. The sign rather has to be interpreted whenever it is used. Therefore, the semiotics of Peirce does not contain any reference of a sign (the signifier) to an object (the signified) without the involvement of an interpretant, which determines the denotation of the sign by means of its actual usage. Peirce summarizes this insight with the following definition of what he calls a *sign*:

> Anything which determines something else (its *interpretant*) to refer to an object to which itself refers (its *object*) in the same way, the interpretant becoming in turn a sign, and so on *ad infinitum*.[18]

According to this definition, the interpretation of signs can be regarded as a process in which different signs succeed each other – like a chain of signs – with each sign serving as an interpretant for the others. This process is called "semiosis".

Of course, it would not be sufficient to consider only signs that refer to objects/things. Therefore, the vertices of the semiotic triangle – sign, object, and interpretant – are rather to be understood as *generalised correlates* of a sign.

Peirce himself notes different attempts to define adequate substructures of these correlates. The probably most widely known attempt subdivides each correlate into three sub-levels – I will also call them "flavours" – depending on whether the category firstness, secondness, or thirdness mainly controls a concrete semiosis. In the context of this well-known attempt, the object correlate – for instance – may occur as "icon", "index" or "symbol".[19] The combination of flavours of the different correlates specifies the interplay of the three categories within each sign-based cognitive process.

Mainly the signs with an *index-like* correlate usually denote a *specific* object. Consequentially the index

18 Peirce, "Elements of Logic", CP 2.303.
19 Ibid. CP 2.274 et seq. Cf. Pape, *Charles S. Peirce zur Einführung*, 125 et seq.

belongs to the category of secondness, since this category governs the confrontation of the individual with the world of facts and objects.

On the other hand, a sign with a *symbolic* flavour does not necessarily denote a specific object in the sense of a token, but may refer to a *class of objects*, i.e. to a type. Astronomical theories, for example, describe the orbits and the motion of planets and moons in a general way. This is a typical manifestation of thirdness. The object correlates of the corresponding signs are of a symbolic type and refer to a *class* of objects (e.g. all kinds of planets and moons and other astronomical objects). By contrast, imagine a geodetic survey of the orbit of the earth's moon during the act of collecting data. In this case, the sign for the moon (I will indicate it by writing "/moon/"[20]) will now denote one very specific object and thus will be of an index-like type, which means that it acts under the regime of secondness. However, to a certain extent it touches the domain of firstness, too, because the observable dimensions of the survey depend on the fundamental capability of man to perceive e.g. the moonlight and (relative) motions in space sensuously. This, of course, is an expression of firstness. The sign /moon/ is of an *iconic* type in this regard. Another example of an icon in the context of astronomical symbols may be a draft painting or a sketch of the moon's orbit. It provides a rough pictographic idea of the motion of the moon in the sky. In this way, it adds a pictographic impression to the straight sensation with the help of a sign that shows a vague similarity to certain aspects of the denoted object (the system of earth and moon in this case).[21]

Turning now to religion, we can ascertain that semiotic tools have been used to investigate aspects of Practical Theology and religious pedagogy since the 1990s. There was a strong intention to analyse religious symbols and their practical usages decoupled from their possible ontic significations. The *act* of using symbols in concrete situations of communication became the focus of research. Examples of this approach can be found in publications of Wilfried Engemann in the area of homiletics, Karl-Heinrich Bieritz in the field of liturgical studies, and Michael Meyer-Blanck in the context of religious pedagogy.[22] These authors agree in their criticism of the symbol theories of e.g. Paul Tillich and Paul Ricœur regarding the dyadic character of symbols.

I do not want to judge whether this criticism of Tillich is justified. I rather want to focus on an important goal of the semiotic approach in Practical Theology: the avoidance of a somehow *"magical"* comprehension of religious symbols and the attempt to understand rather *the practice* of using symbols *in actu*, i.e. in the context of the communication setup.

On the Relation Between Religious and Scientific Sign Systems

The examination of theological topics with semiotic methods raises the question: which objects do religious signs actually refer to? Let me focus on three different specifications of *objects*:

1. According to Kant, an *object* is something to which a term or a concept refers that covers the variety of aspects of a given intuition.[23]
2. In the context of physical research, objects are instances of certain classes (of objects). In other words, objects are tokens that belong to certain types, which in turn are derived from certain interpretations of theories. An interpretation of a theory attributes a set of observables or states to each type and thus provides a more or less complete specification of it. The preparation of objects for an experiment (e.g. in a laboratory) transforms the interpretation of a theory into a material supply of tokens, which correspond to the object types described by the theory and its interpretation.
3. From the semiotic point of view, an (concrete) object is something that can be denoted by an index. Thus,

20 /…/ indicates that the signifier is addressed, not the meaning of a sign.

21 Umberto Eco emphasises that iconicity does not mean a similarity between the sign and the object per se but a similarity between the sign and the *conventions of perception* of it, i.e. its perception model. Eco, *Einführung in die Semiotik*, 209-213; this publication is partly based on: U. Eco, La struttura assente. La ricerca semiotica e il metodo strutturale, Milano 1968.

22 For instance, Engemann, *Semiotische Homiletik;* idem, "Kommunikation des Evangeliums als interdisziplinäres Projekt" and references therein, 137-232, esp. 156 et seq.; Bieritz, *Zeichen setzen;* Meyer-Blanck, *Vom Symbol zum Zeichen*.

23 Kant, „Kritik der reinen Vernunft", B 137.

objects are significations of signs, which are applied in a perceptual situation that is mainly governed by secondness. However, secondness is brought about by thirdness. In other words, objects are the occurrences of the direct confrontation of the individual (the subject) with his environment, where this environment is in turn structured and constructed by a symbolic-theoretical act of interpretation.

These three specifications imply more or less the same definition, but each of them takes a different perspective. The second statement details the first statement in the context of empirical and physical research. The third statement translates the second one into a semiotic point of view.

What are the *objects* of religious belief that meet the specifications above? Would, for instance, *God* be among them? According to Kant, this is not the case; for Kant, "God" is a regulative idea and not a concept of an object, where the imaginations related to it can ever lead to cognizance of it.[24] Furthermore, I have some doubts that a human being would be able to face God in the sense of secondness, i.e. in the sense of an "outward clash". Referring to mystical literature, I would rather expect some sort of "inward clash" instead.

Similarly, this holds for all the angels, heavenly creatures and powers, an encounter with whom would rather be possible on a narrative and quasi "inward" level.

Of course, there are signs that refer to religious entities in the way of an index. When I point to the Host in a Mass stating that this Host has been left over after the Holy Communion, I obviously use an index-like sign. In this sense, I talk about an object in a religious context according to the third specification of objects above. However, do I really apply, let's say, a religious sign in this case? Isn't it rather housekeeping? I want to take it this way: as long as I refer to the Host with an index-like sign, i.e. as long as the Host serves as an object, it will simply be regarded as some kind of bread. However, this does not constitute a religious usage of the sign /Host/. In religious language, the Host is a symbol rather than an object.

This indicates a more fundamental difference between religious and scientific sign systems. *Natural sciences* intend to describe natural *entities* – objects –, the relationships between them, and the corresponding laws of nature (even if the references to objects are ambiguous in natural sciences, as we have seen above). By contrast, the assumption that *religious language* has references to objects at all is rather problematic.

Hence, scientific and religious sign systems are categorically different from each other in a twofold sense. On the one hand, they are categorically different regarding the everyday meaning of the term "category", which implies the classification of things into a conceptual schema.[25] Since categories establish the perception and the conceptual cognition of objects, two different category systems will generally determine a different set of objects. In other words, one and the same term will denote different objects when it is used in the context of different category systems.[26] On the other hand, scientific and religious sign systems are categorically different in the sense of Peirce's table of categories. While sign systems in the natural sciences need to specify objects in order to make empirical theory testing possible, religious sign systems do not need to specify objects and to include indices into their body of signs. That is, natural sciences interpret the world objectively for the sake of empiricism, whereas religion interprets the world symbolically or in a narrative manner rather than as a formation of objects.

While religious sign systems lack references to concrete objects, the sign systems of natural sciences lack narrative and – in some sense – performative power. However, narration without object references is as barely concrete and imaginable as objectivity without narration appears to be cold and dead. Therefore, science and religion should take advantage of each other. How can this be possible in the face of the (twofold) categorical differences between these two worlds? Would this not lead to severe category mistakes?

It will be possible, indeed, if we look at an individual's exposure to both worlds. I will show that religious sign systems provide a certain type of symbols and practices, which allow the individual to relate religious beliefs to other contexts of cognition like sciences or everyday experiences.

24 Cf. about the concept of ideas: Kant, „Kritik der Urteilskraft", B 192-B 199. Concerning the concept of God as a regulative idea, cf. Jonkers, "Living as if God exists".

25 In this sense, Gilbert Ryle looks into the problem of category mistakes. Ryle, *The Concept of Mind,* 6 et seq.

26 Cf. Stahlberg, „Ein Universum für alles?", 335.

I want to explain this by giving an example: the Christmas story as Matthew tells it.[27] I am particularly interested in the role of the *star* within this tale. We know of quite a number of attempts to interpret the star of Bethlehem as a natural phenomenon, which may be open to investigation with astronomical methods. The most popular of these interpretations classifies the star as a specific comet. Some scientists claim a special constellation of the planets Jupiter and Saturn at the estimated birthday of Christ, where these planets may have looked like a single star.[28] Others speculate about Supernova events or other stellar phenomena.

A straightforward identification of the denotations of scientific signs with those of religious signs would usually cause category mistakes. The sign /star/ in the narrative context of the Christmas story refers to something completely different from what the same sign refers to in a lecture on astronomy. The Christmas story does not address a celestial body, but an *insigne* of the newborn Saviour.

However, the wise men in the tale discovered the star of Bethlehem *in the sky*. Does this indicate a category mistake in the Christmas story? Yes, indeed, but a legitimate one, because the insigne is addressed metaphorically there!

According to Nelson Goodman, metaphors are "calculated category mistakes".[29] They "carry over" ("meta-phere") the meaning of certain signs from one category to the next and from one sign system to the other. This "carry-over" is not realized by logical or conceptual connotations between categorically different sign systems. On the contrary, it is realized by small perturbations that allow appearances of denotations, which are alien to a certain sign system but are fragmentally imported into it from a different one. This perturbative import of significations into a sign system takes place mainly *on an individual level*, because metaphors gain their specific expressions in the course of the (individual) *act* of telling and reading a story or by listening to it. The connotations that evolve from this kind of "carry-over" have neither a logical purpose nor an ontic meaning in at least one of the sign systems involved. Thus, they can be intimated to a very limited extent only.

I want to paraphrase this result by saying that the sign system (the "perturbed" one) will just be affected "spuriously" by this kind of category mistakes. Therefore I call the latter "*spurious* category mistakes". In the following, I will try to differentiate between these *spurious* category mistakes and the *"genuine"* ones that cause logical and conceptual misunderstandings.[30] I will do that by taking a semiotic look at the issue based on the already discussed example of the sign /star/ in its different categorical contexts.

In the context of natural sciences, this sign usually denotes a certain class of astronomical objects, namely balls of hot plasma with thermonuclear fusion inside. However, in the context of the religious narration, the meaning of /star/ is different. It does not refer to a physical entity or to a class of objects; rather, it denotes an *insigne*. This in turn serves as an interpretant of another sign (/Saviour/) that denotes the newborn Saviour, who is, of course, neither a thing nor a glittering spot in the sky but a narrative figure. The insigne has the same reference as the sign /Saviour/ within the religious context. It has also a reference to an *object* in the sense of an astronomical entity, but only in a symbol system that is different from the religious one. From there it transfers attributes (like brightness, serenity, reliability, supremacy, etc.) to the religious context. It is important to notice that this does not happen on a conceptual but on an iconic level.[31] This process alienates the respective attributes from their original meaning. They lose some of their meanings and connotations and gain a partial reinterpretation that fits into the new context.

This is not a matter of *knowing* what a metaphor or an insigne "means" or how it should be interpreted correctly. It is rather a matter of *giving the signified* of a signifier (like /Saviour/) additional attributes and meanings *in the sense of real presence*.[32] However, it is a real presence that does not immediately change

27 Mt 2,1-12.

28 For instance, Johannes Kepler provided corresponding astronomical calculations. Cf. Hansen, "Kepler und der Stern von Bethlehem", 42-47.

29 Goodman, *Languages of Art*, 73.

30 Formerly, I distinguished between "local" and "global" category mistakes, but the new terms mentioned here seem to be more convenient. Cf. Stahlberg, "Gebetsfehler".

31 Note that even Peirce regards metaphors as icons; Peirce, "Elements of Logic", CP 2.275.

32 The effect of the insigne described here is inspired by the concept of symbols that is suggested by Hans-Georg Gadamer. Gadamer, *Die Aktualität des Schönen*. Cf. also Stahlberg, "Wortvergegenwärtigungen", 277 et seq.

our conceptual worldview of sciences or the dogmatic view of religion, but appears perturbatively and individually only. This process requires actual performance in the sense of plots and speech acts that help to envisage and to realize the expression of an insigne or of a metaphor.

Religions provide various traditional possibilities to aesthetically percept and envisage the expressions of signs like words, texts, narrations, pictures, insignia, etc. Some examples are gestures of prayer, liturgical plots, music and singing, and not least the act of storytelling. One cannot really grasp the Christmas story, for instance, merely by knowledge of the meaning of the terms and symbols that come along with it. Traditional tales and even religious narrations long for repetitive telling, extolling, celebrating, and rejoicing, and so on. They long for artistic representation, devotional empathy, spiritual hermitage, faithful pilgrimage etc., in sum, continuous presence in life. In the long term, this will be a certain kind of continued interpretation of narratives during one's life, in terms of ritualized practice and acting.

This way of establishing connotations between religious narratives and scientific research (or daily experience, too) may influence not only the religious beliefs of a person but his perspective on scientific objects either. If a narration like the Christmas story has a certain presence in a person's biography, s/he will be able to develop a different individual view on physical objects like stars. This even holds for astronomers.

However, this is not the whole story. As I have pointed out above, there is a certain ambiguity in natural sciences concerning the descriptions of objects. *The texture of physical entities and the relations between them may therefore be affected even by a retroactive influence of religious narratives on the treatment of signs in natural sciences.* At the first glance, this sounds a bit fantastic, but with regard to the term "God Particle", this statement may become more transparent.

Most physicists (and theologians as well) scorn the neologism "God Particle"; and they are right in doing so, because this term combines two signs that are categorically as different as signs can ever be. It looks like *the* category mistake per se.

Wherever this neologism may come from,[33] the connotation between science and religion intrinsically lies within it. If the term "God Particle" is used with the intention to suggest that the Higgs mechanism provides any insight into the acting of God in the physical world, this will induce a severe and genuine category mistake. Any serious impact of it on the scientific world-view would even undermine the identity of natural sciences. Fortunately, this has not happened to the "God Particle" yet (apart from some publications in the popular sciences). In other contexts, however, similar category mistakes have been used to bolster schools of thought such as creationism.

The natural sciences do not provide generally available techniques or ritual practices that help to envisage and to realize expressions of signs coming from other categorical contexts, as religion does. However, abductive, heuristic, and illustrative processes for creating new ideas may play quite a role in the everyday life of researchers.

The "God Particle" illustrates a possibility to establish a positive feedback loop that allows a perturbative (re-) import of significations from other categorical regimes (like religion) into sciences by means of a *spurious* category mistake. What I mean is a category mistake in the sense of a jocular usage of the term "God Particle". Not only metaphors but also jokes can serve as "calculated category mistakes". If we adopt a rather witty attitude to the term "God Particle", it may ironically reveal the echoes of pseudo-religious motifs in the standard interpretation of the Higgs mechanism and question it that way. This, in turn, could be an additional incitement to consider alternative interpretations and to enlarge the spectrum of possible objectifications of physical theories. Of course, individuals differ in their incitements, but in all, there may be a long lasting impact on the basic convictions of the scientific community.

33 Lederman, Teresi, *The God Particle*, xi.

Conclusion

In religion, certain ritual habits, like storytelling, prayer, and worship, can foster a link between religious beliefs and the content of non-religious sign systems (e.g. the natural sciences). This link is not a conceptual or systematic construction of ideas, but rather a special form of category mistake that confronts the ontic denotations of different sign systems to each other, namely from the perspective of the individual. In this way, the signs of different systems are interrelated on an individual level, but – in the long run – with a feedback loop to the sign systems themselves beyond the individual point of view.

On the other hand, a ready wit and a sense of humorous views on scientific narrations and their relation to religious contexts may provide additional bridges between both realms by means of spurious category mistakes. These allow us to gain a glimpse of the significance originally belonging to one sign system in the context of the other one – without the danger of mixing up both worlds conceptually.

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