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On semiosis in physics and in nature

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Abstract: This paper explores the intersection of C.S. Peirce's triadic semiotics, Whiteheadian process philosophy and the methodology of modern physics to propose a unified model of semiosis. We introduce the concept of the personified community of physicists (PCP) to delineate five cognitive stages of scientific inquiry—from elementary measurement to the construction of a total model universe. By extending this framework into the domain of physiosemiosis, we argue that semiosis is not exclusive to conscious observers but constitutes a fundamental characteristic of natural processes, where the 'measurer'—whether human or inanimate—

functions as an agent of interaction. Central to our thesis is the situatedness of existence: the truth conditions of physical claims are shown to be dependent on their pragmatically efficient locality within a semiotic field. We further demonstrate how methodological tools from theological thought patterns—theosemiosis—can clarify the ultimate grounds of reality through the interplay of Immanent and Transcendent Absolutes. Ultimately, the paper describes the recursive semiotic structure of scientific cognition in physics and its relation to natural processes. In this sense, it outlines a non-reductionist framework for reinterpreting the physical worldview through semiotic categories.

Keywords: *cognitive semiosis, existence, methodology of physics, natural semiosis, personified community, philosophy of science*

Introduction

Although the laws of physics are presented in the language of mathematics, physicists' striving for a level of formality comparable to that of mathematics is not fully realized due to the irreducibility of the human context. Physical relations do not easily lend themselves to a dualistic treatment. For example, in the case of the object–property relation, properties manifest in measurement data as individual values that change over time for a single object and also vary from object to object. Interpreting these as universals (and also treating the object as a universal) often resembles art more than exact science. The interpreters, in turn, are specific individuals living in a specific society. For example, the journey from observing the swing of a chandelier to the law of the pendulum was made possible, among other things, by Galileo's personal qualities and the social context of the era (Gribbin, 2002, chapter 3). According to the pragmatist Peirce, who originally worked as a physicist, the dyadic relations common in the natural sciences, such as the cause–effect relation, are insufficient, and a semiotic approach and logic are needed. According to Peirce, logic is merely another name for semiotics (1994; hereafter CP 2.227). Peirce describes semiosis as triadic: referent (semiotic object)—representamen (the sign-bearer representing the sign)—interpretant[1]. Semiosis allows us to explicitly distinguish between referring to the object under study (referent), its representamen (sign) and meaning (interpretant).

In Peirce's time, following the discovery of electromagnetism, classical physics began to encounter difficulties, and the need arose to generalize classical logic as well.[2] Mach (1893 [2013], p. 255) adopted a rather radical stance, insisting that physical knowledge be grounded solely in observation and remain free of any metaphysical assumptions, however reasonable they might seem. Mach's ideas significantly influenced both Einstein's development of general relativity (GR) and Heisenberg's foundation of quantum mechanics (QM). Unfortunately, problems soon arose in reconciling GR and QM that remained insurmountable. The issue is not only worldview-related, but it has significantly hampered the development of physics (e.g., quantum gravity or QG).

In this article, we seek the necessary ideas and context for solving problems related to the physical worldview by relying more on humanity's earlier achievements—including in non-natural-science—rather than entirely novel ideas. This requires achieving fruitful cooperation between physics, mathematics, (mathematical) logic, philosophy, semiotics and theology. Cooperation begins with a fruitful dialogue in which terms and problems originating outside the exact sciences are treated in a way that allows them to be included in the discussion of the foundations of physics (Kasak and Kull, 2018). The greatest difficulty lies in the fundamental difference in methodology and way of thinking, but this also brings with it the opportunity to notice what was previously unobserved.

Due to the interdisciplinary nature of our approach, it is sensible to outline our starting point in all relevant disciplines. In terms of mathematics, we rely on the established foundations of logic and set theory (see, e.g., Curry, 1963; Fraenkel and Bar-Hillel, 1958; Potter, 2004) on the one hand, and the mathematical treatment of the fundamental relation of being a notation-denotation (Lorents,

1 In Peirce's semiotics, a sign is a sign insofar as it signifies something other than the object *A* itself to someone (or something): for example, a traffic sign is in itself just a piece of painted metal, but for a road user it signifies something else. A sign [in semiosis, *representamen*] is the *first* in a triadic relationship *with something else*, called its object [in semiosis, *referent*], so that it is capable of determining a *third* [in semiosis, *interpretant*], which acquires the same triadic relationship with its object as it itself has with that same object. The interpretant is everything that is explicit in the sign itself, outside its context and the circumstances of its utterance. The interpretant does not have to be mental. See the longer explanation in CP 2.228–2.242. Below, the term 'semiosis pole' is used as a collective name for referent, representamen and interpretant.

2 Peirce was among the first developers of three-valued logic (Fisch and Turquette, 1966).

2001; 2010) on the other. Philosophically, we take as our basis Peirce's (1994) pragmaticism and Whitehead's (1929 [1978]) process philosophy, in semiotics, Peirce's (1994) semiotics and Deely's (2005) physiosemiosis[3], and in theology, Plotinus' (1984) concept of God. In terms of physics, we try to follow the physical worldview described by, for example, Grodzicki (2021). Initially, we start from the worldview of classical (including relativistic) physics and then try to understand what changes has quantum mechanics brought about.

1. Clarification of terminology

When it is said that physicists know, who then knows? In attributing common beliefs or knowledge to a group of individuals interacting on a given question (e.g., a community or a school of thought), we use the term 'personified community', following Dworkin (1986, pp. 167–168). A member of the community is aware of the community's positions, which do not need to be justified within the community, and at the same time, a member of the community need not share the community's views (in everything), but must be prepared to justify their differences. Below, the abbreviation PCP denotes the *personified community of physicists*, and when speaking of physicists, we primarily start from the contextual and manifest attitudes of this community.

In society's endeavors to use the resources of the material world, it became apparent that systematic, rational knowledge of that world is practically useful. Initially, this knowledge was established as useful wisdom, such as the rule of the lever or Archimedes's law—wisdom that, for the most part, was consistent with so-called common sense.[4] The beginnings of the science of physics in the sixteenth century could be associated with the shift among scholars to regard observation and experiment as the only reliable criterion for truth. Research results were presented following mathematics and logic, without hesitation even when the results seemed to contradict common sense (e.g., classifying the Earth among the moving celestial bodies)[5].

[3] Instead of 'physiosemiosis', we hereafter use the term 'natural semiosis', which has a slightly different meaning.

[4] Here, this refers to the views of the society interested in the issues at hand as a personified community.

[5] The separation of philosophy from common sense during the time of the Eleatic school seems quite analogous.

In the early evolution of science, the common-sense worldview was the point of departure, refined by pragmatic wisdom and teachings from mathematics, philosophy and theology. Starting with Galileo, one can speak of physics as a natural science concerned with the study of the most general regularities of the material world using the language of mathematics. A personified community of physicists emerges from the moment terminology becomes sufficiently organized to allow specialized knowledge to be treated as a logically coherent and consistent system.

PCP's foundational assumptions about reality may be summarized as follows:[6]

- There is an external world[7]—that is, objective reality or nature—which exists outside and independently of consciousness.
- Nature has a structure that is independent of perception, some of which may be directly imperceptible.
- Nature is cognizable and may include components that are capable of mental processes, including conscious processes, when cognizing nature. A mental entity can influence nature, though not the laws of nature.
- Nature is governed by the laws of nature. The structures of reality can be described by strict mathematical laws.
- The totality of events in nature can be broken down into repeatable, separable components.
- A repeatable experiment conducted under the same conditions must yield identical results, independent of the experimenter.

Physics describes nature using models, but transferring model-based explanations to reality is problematic. The PCP worldview rests on universal fundamental principles. The origin of these principles and the basis of their operation are unclear. Science relies on logic, whose principles seem to reflect reality. Their origin and scope of application are unknown.

According to PCP, physics provides models that describe and predict empirical processes, which consist of the following components:

- *Physical objects*: bearers of essential properties;
- *Physical quantities*: properties and their values;
- *Laws of physics*: relations between physical quantities.

6 The list is not exhaustive.
7 Below, we refer to this as the *natural universe*.

The extremely equivocal term 'existence' is attempted to be used here in a restricted and somewhat mathematical sense.[8] Such usage may be justified by the constructive (i.e., consistent with intuitionistic mathematics) use of the expression in a physics-related context. We assume that the existence of any entity *x* is world-bound—along with its existence, the existence of the world or universe U_j containing it is presupposed. The subscript index *j* defines a specific world from the set of contextually grasped worlds. The existence of the world U_j itself, its possibility, necessity, or impossibility, is a separate question that we do not attempt to solve in general form. We consider only universes that are unavoidable when talking about physics. It seems that the existence of immediately accessible universes is also immediately accessible, while others inevitably remain speculative. This is confirmed, for example, by the colorful history of descriptions of the universe considered real.

Let $Exist_j(x)$ denote the situation where the entity denoted by *x* exists in the universe U_j. If the universe in question is immediately accessible to human description—like the universe of mathematical objects U_M—then the construction $Exist_j(x)$ may be treated as a true or false statement, depending on whether the entity *x* exists or not. For this, a sufficient set of existence conditions must be met, which can be expressed as a conjunction of corresponding formulas C_X or as a set of conjuncts Con_X. The subscript *X* refers to the fact that the elements of such a set of statements, including the number of elements, may depend on the entity *x*. The existence statement of entity *x* is presented by formula (1):

$$(\exists x C_X) \supset \mathrm{Exist}_j(x), \tag{1}$$

where C_X denotes the conjunction of all conditional statements. The choice of the set Con_X may depend on the description and the describer.

We briefly describe the universes used within PCP, starting with those immediately accessible:

U_E—empirical universe: all phenomena experienced directly or using measuring instruments that can be interpreted as data in the PCP sense.

U_M—mathematical universe: the world of entities of pure mathematics. According to the consistent materialistic stance quite common in PCP, these are abstracted from experiences of the real physical world, analogous to other

[8] Scruton (1994, p. 141) calls this type of analytical philosophy of being 'the Sparse Theory of Being'. According to this theory, being is dependent on a foundational theory, the truth of which we initially solve in a pragmatic manner, following the example of Quine (1968).

conceptual universals. In this case, they can be treated together, similar to natural kinds in the physical world. Some alternatives are worth mentioning here—for example, mathematical units have also been treated as part of the third world in Popper's sense (1968) or as a Platonistic primary world, where, for instance, Tegmark (2014) claims that the physical world itself is a manifestation of the mathematical world.

U_T—theoretical universe: the most general possible system of the laws of physics and physical objects, presented in the language of mathematics adapted for physics and consistently adjusted in response to new empirical data (see Grodzicki, 2021).

U_P—the model universe of physical reality: created by PCP based on empirical data, the theoretical universe, along with mathematics and logic. Added to these is a broader context that PCP interprets based on principles, metaphysical stances and beliefs corresponding to the prevailing paradigm.

U_N—natural universe or real material universe (nature): as the object of study in physics, whose existence is generally not doubted within PCP. Mental beings, such as physicists, exist in the real universe as bodies with mental properties and conceptions of actual and fictional universes. These manifest by living materially in the material world as persons and social beings who use language for communication. For the verification of the existence conditions of an entity, an immediate perception of truth is needed, which unfortunately is not attainable according to the PCP worldview. Statements of existence conditions expressed by PCP inevitably present the existence conditions of a real entity approximately and depend on the PCP world model and metaphysical prejudices.[9]

In this article, we presuppose the existence of the natural universe U_N as the object of study for physicists because doubting its existence does not seem to contribute to tackling problems related to the physicists' worldview.[10] We define the sole condition of existence, following Plato's unnamed Eleatic, that *e* is an entity in the natural universe U_N only if it participates in at least one interaction (Plato, *Soph.*

[9] The requirement of immediate truth could be replaced by the assumption that mathematics can describe reality accurately and that we have access to the mathematical universe. This seems to help avoid mystical patterns of thought, but there are currently no generally accepted arguments in defense of such a position. (If all processes can indeed be adequately described by mathematics, this supports the simulation argument.)

[10] Refraining from doubt here is related to Scruton's (1994, p. 17) presupposed epistemological necessities, but we do not rule out that this postulate may nevertheless prove to be questionable or even false.

247d–e). This definition is consistent with the pragmatist position that it makes sense to speak of the existence of an entity precisely when it somehow affects the world. Unfortunately, we must consider that PCP is capable of cognizing only those U_N entities whose basic properties are explicitly describable or at least contextually graspable. The existence of a particular entity *e* can be associated with identity[11] ($x = e$) somewhere and sometime (in the spacetime segment ΔV), where C_X means: "At least one interaction takes place in the spacetime segment ΔV with the participation of *x*"

(2) $$[\exists x\ ((x{=}e)\ \&\ C_X)] \supset \mathrm{Exist}_{U_N,\Delta V}(e).$$

Quite often, the equality relation is misused to link a *notation* (sign, name, designation, etc.) with a *denotation* (thought, content, etc.). However, being a *notation–denotation* is fundamentally the same in nature (or at least one might treat it as such), such as being an element. For example, the green color of a traffic light *denotes* that movement (in a given direction) is allowed. We will use the symbol ∫ to represent this relation (e.g., $\exp(m,n) \int m^n$). The formation of an ordered pair of this kind, where the one in the first position is a *notation* for the one in the second position—or vice versa, the one in the second position is a *denotation* for the one in the first position—we can henceforth call *defining*, and the ordered pair itself *knowledge*, according to Lorents (2001). Someone or something (e.g., some conglomeration, a system of ordered sets, etc.) *knows* if it contains some kind of knowledge. Systems (i.e., sets whose elements have some fixed properties or relations) may be called *intelligent systems* if they are capable of operating with knowledge (e.g., *identifying* existing ones or, conversely, *distinguishing* them, *creating new* ones from existing ones, or, conversely, *destroying* them, etc.). Thus, *intellect* is the capability to operate with knowledge (Lorents, 2010). We presuppose that PCP is an intelligent system (see, e.g., Dutton and Lynn, 2014).

Using the binary fundamental relation of being a notation–denotation—or a relation for which, by agreement, no definition is given—we can rewrite the formula (2) presented above as follows:

(2′) $$[\exists x\ ((x \int e)\ \&\ C_X)] \supset \mathrm{Exist}_{U_N,\Delta V}(e).$$

It should be noted here that only one of the forms of existence proposed by Lorents was used—namely, *normal* or *usual existence*, denoted by *Nexist(x)*.

[11] Here, we have attempted to follow Quine's (1968) basic approach. On the problem of identity and existence, see, e.g., Scruton (1994, pp. 143–148).

Normally, *something exists* if the something in question turns out to be the notation of something or turns out to be the denotation of something. Put briefly,

(2′′) $$(\alpha \int \beta) \supset \mathrm{Nexist}(\alpha),\ (\delta \int \gamma) \supset \mathrm{Nexist}(\gamma),$$

from which—relying on the derivation rules of both classical and intuitionistic logic (see, e.g., Takeuti, 1975)—one may derive

(2′′′) $$[(\alpha \int \beta) \vee (\delta \int \alpha)] \supset \mathrm{Nexist}(\alpha).$$

From this, we can derive a slightly updated formulation of (2′) along with its "formal counterpart":

(2′′′′) $$[\exists \mathrm{x}\ ((x \int e)\ \&\ C_{\mathrm{X}})] \supset \mathrm{Nexist}_{\mathrm{U_N},\Delta \mathrm{V}}(e),\ [\exists \mathrm{x}\ ((e \int x)\ \&\ C_{\mathrm{X}})] \supset \mathrm{Nexist}_{\mathrm{U_N},\Delta \mathrm{V}}(e).$$

This suggests that PCP as an intelligent system infers the possession of knowledge from the notation–denotation (i.e., representamen–interpretant) relation of entity e, on the basis of which it assumes that this knowledge is also quite close to the truth concerning the existence of e as a referent in nature's (U_{N}) spacetime segment (ΔV). In doing so, the existence of time and space is presupposed (based on empirical experience and mathematics), and these as means of understanding the world are projected back onto nature.

The existence of entities corresponding to universals is a separate question, since such entities are not located in space or time; their being is similar to the being of mathematical units. Universals as generalizations of particulars can also be treated as a set whose elements, the particulars, are bound by a fixed set of rules (code) for being a member of that set, which in set theories and so-called algebraic systems theories are presented by relevant axiomatics (see Fraenkel and Bar-Hillel, 1958; Potter, 2004)—and to which, in a natural (logical) way, are associated certain statements presenting the possession or non-possession of properties by the elements. The set of these statements or the formulas presenting them (such as "element x possesses property P", i.e., $P(x)$, or "element y does not possess property Q", i.e., $\neg Q(y)$) in turn forms a set that often deserves separate consideration. Since the properties of real objects may vary greatly (even to the point of emergence and disappearance), a universal encompassing real objects is rather a fuzzy set, in which the degree of validity of the statements-formulas expressing *membership as an element* are evaluated with real numbers from zero to one. This allows for the treatment of situations where an element emerges by partially belonging to other fuzzy sets, evolves into a typical representative and eventually loses those properties, changing into something else or even becoming non-existent. A universal defined by a fuzzy set may be referred to as a fuzzy universal.

In the universe U_N, the universal w may exist independently of the existence of the members encompassed by it, provided that their existence is possible. That is, the universal w is not necessarily empty, i.e., $\neg\Box\ (w = \varnothing)$. Using the notation Set[12] here as a (meta)predicate of *being a set* sometimes occurring in set theories, this condition presented in the preceding paragraph may be expressed formally in the following way:

$$[\mathrm{Set}(w)\ \&\ \neg\Box\ (w = \varnothing)] \supset \mathrm{Exist}_{U_N}(w). \tag{3}$$

PCP semiosis develops through individual subjects. Figure 1 illustrates the referents of individuals (observation results), which are shaped in thought as interpretants (concepts, propositions, etc.), and their representamen is a word or sentence or a text consisting of words connected into sentences. During communication, the interpretants of individuals converge into an intersubjective interpretant, which in turn influences the subjects' interpretants. The community standardizes the representamens into the most unambiguous text possible, which presents the intersubjective referent as the PCP model of the entity in question.

In addition to empirical experiences, the formation of the interpretant is also influenced by the interpreter's subjective and societal experiences. The experiences of each PCP member (observation plus communication) continue to shape the interpretant within them. A specific individual may maintain personal differences, but they have the obligation to justify their differences when presenting them. For an already established intersubjective referent and representamen, this scheme reduces to Johansen's (1985, pp. 265–266) pyramid of semiosis.

Notation conventions used throughout the figures are as follows. Capital letters denote the poles of semiosis: R—*referent*, E—*representamen*, T—*interpretant*; lowercase letters preceding the capital letter denote the stage of semiosis: a—*elementary*, i—*immediate*, d—*dynamic*, f—*final*, *total* is omitted; superscripts denote domains: P—*physical*, N—*natural*, M—*mathematical*, H—*ethical*; G—*theological*, S—*subjective*, O—*social*; subscripts j, k indicate the feature number of the individual case.

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12 For the notation for *being a set*, see Kuratowski and Mostowski (1967, ch. I, §2) (notation Z) or Mendelson (1987, chapter 4, §1) (notation M).

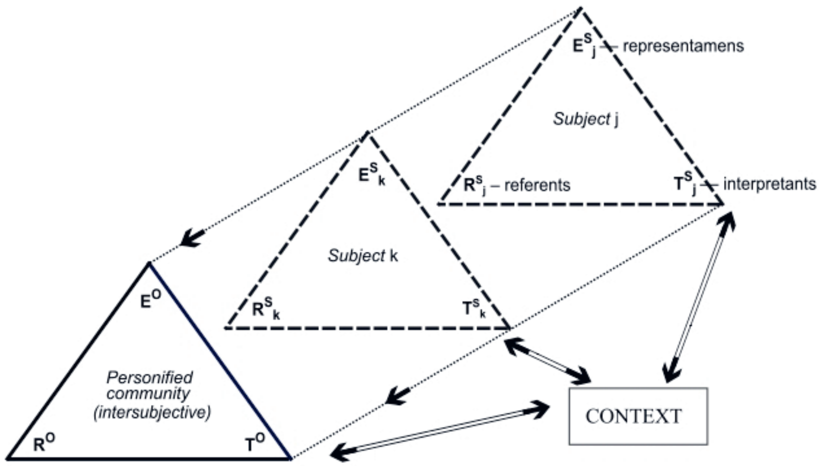

Figure 1. Schema of PCP intersubjective semiosis. The subject's empirical experiences (data, observation results, etc.) are supplemented by the interpreter's subjective and societal experiences through the context.

2. Stages of PCP semiosis as cognitive semiosis

The research method of physics can be considered to consist of stages: manifestation of the phenomenon(a)—posing the problem—gathering initial information—formulating the hypothesis—testing the hypothesis by observation or experiment—data analysis—drawing final conclusions (see, e.g., Urone and Hinrichs, 2022). The need to pose a problem may arise from the researcher(s)'s own empirical experiences or from a community order, when the phenomenon cannot be explained with sufficient accuracy on the basis of prior knowledge. (For instance, the need to determine the extent of expansion of metal objects due to heat with the accuracy required by the client.)

Generalizing on Peirce's stages of semiosis[13], we divide PCP semiosis into five stages in the epistemic process:

- *Elementary*, based on the experience of a direct measurement or observation act;

[13] Peirce distinguished between immediate, dynamic and final interpretant. In our distinguished stages of semiosis, the corresponding interpretants have a similar role (see CP 8.314).

- *Immediate*, based on the experience of the phenomenon, the treatment of measurement acts as a phenomenon relies on the PCP paradigm and influences the planning, execution and interpretation of observations;
- *Dynamic*, based on the experience of the object (or event, or simply a set of properties), the treatment of phenomena as manifestations of the object (or equivalent) relies on the PCP paradigm and influences observations;
- *Final*, based on the experience of the relation or relations between objects (or equivalent), the description of the change in object properties is presented in the language of mathematics and relies on the PCP paradigm and, in turn, influences observations;
- *Total*, based on the combination of all empirical experiences in the language of mathematics according to the PCP paradigm.

Research is preceded by a **preparatory PCP semiosis** stage, similar to immediate PCP semiosis, in which the PCP's attention focuses on a particular phenomenon. During this process, hypotheses are proposed to explain the phenomenon, followed by experiments or observations that should test the hypotheses (see Figure 2). What awakens the PCP's interest are initial observational data or descriptions (interpretant), which are associated with certain properties (representamen), which in turn refer to a particular phenomenon (referent).

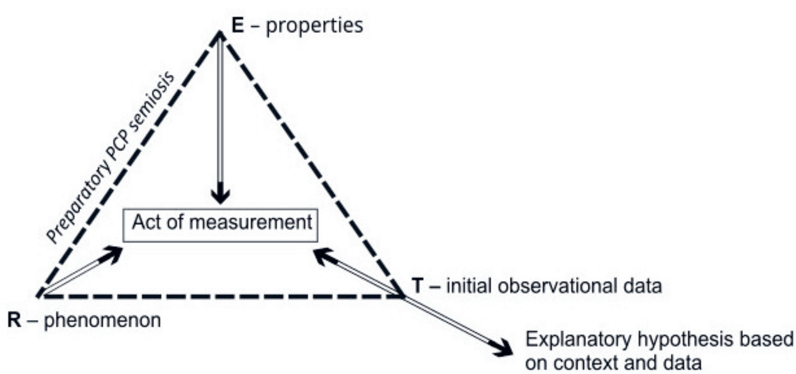

Figure 2. Schema of preparatory PCP semiosis from the manifestation of a phenomenon to the posing of a research problem and the organization of an observation or experiment.

Hypotheses are influenced by the general, research group and individual researcher context. The basic hypothesis of the experiment or observation shows which properties need to be measured, how accurately they must be measured and within which value range the measurable physical results are expected to fall. The experimental setup and measuring instruments are selected based on this information and technical capabilities.

As an example, we examine in this and the subsequent semiosis stages a possible sequence of semioses related to the study of light. The referent of the preparatory semiosis were light phenomena, whose representamens manifested as properties of light as a phenomenon, such as its very high propagation speed, tendency to travel in a straight line, its capacity for reflection and refraction, etc. The interpretants were initial data, such as infinite speed, colors, etc. Based on these, attempts were made to explain light even before the emergence of the science of physics (e.g., Aristotle and Euclid).

Elementary PCP semiosis describes the formation of a measurement result as an interpretant from the measurement experience (as a referent) through the measurement reading (representamen) (see Figure 3). The measurement reading fixes the extent of the measured effect. The measurement result is obtained by interpreting the measurement reading through model quantities, units, etc. used in PCP, where the uncertainty of the measurement is also estimated. Context plays an important role already in the organization and execution of the experiment and in the choices of interpreting the measurement reading.

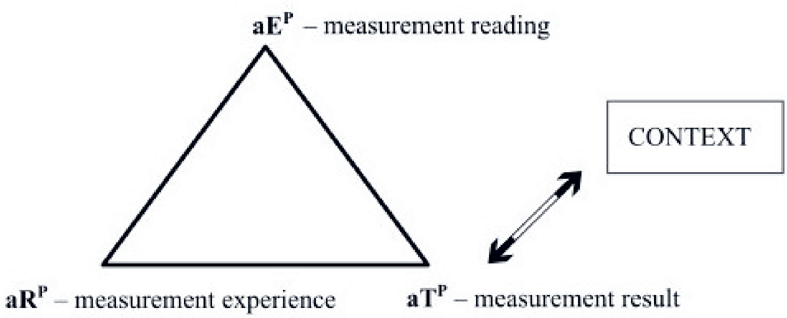

Figure 3. Elementary PCP semiosis presents the formation of measurement experience into a measurement result that fits the PCP context and whose most influential aspects in the elementary stage are, for example, data classification, units, presentation method and personal experience.

Based on the hypothesis of light as a wave in the ether (*luminiferous aether*), Huygens (1690) developed the wave theory of light, and based on the hypothesis of light as a flow of corpuscles, Newton (1704) developed the corresponding theory. The theories were tested with observations and experiments. The measurement results, which were initially consistent with both theories, are the interpretants of the individual cases of elementary semiosis in this context.

Immediate PCP semiosis presents the properties of an empirical phenomenon determined through measurements. Usually, several properties of the phenomenon are measured. The same property may manifest with different values in different cases, and for a single case, several measurements are made for the sake of accuracy. Thus, in the case of immediate semiosis, the characterization of the phenomenon is formed by combining a set of relevant elementary semiosis cases. The properties of the phenomenon manifest as a set of relevant raw data (measurement readings), which the interpretant combines into a pattern of values, that characterize the experienced phenomenon and are adapted to the context (see Figure 4).

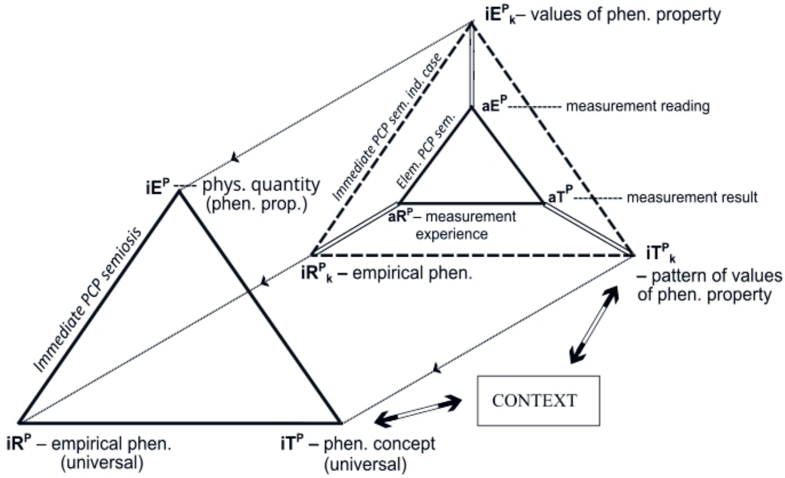

Figure 4. Immediate PCP semiosis. The empirical phenomenon (referent) is presented through its properties (representamen), and the interpretant combines the measurement results of elementary semiosis cases into a pattern of values adapted to the context. The dashed triangle denotes a single case of immediate semiosis as a collection of elementary semioses (double lines). The thin slanted line shows the convergence (including choices) of the individual cases of immediate semiosis into a holistic treatment of the phenomenon, i.e. the particulars are generalized into a universal.

Regarding the structural elements in Figures 4 through 15, each triangle represents a specific semiotic process. The nested inner triangles represent lower-stage semioses which, at each level, aggregate into a single instance of the subsequent stage (e.g., the poles of immediate semioses constitute the poles of a dynamic semiosis). These transitions are typically depicted with double lines. The thin slanted lines illustrate the generalization of individual semiotic instances into a comprehensive case within the same stage.

The most influential aspect of context in the immediate semiosis stage manifests in the description of data with model quantities expressed in the text. These descriptions take into account the properties considered relevant in the given context. PCP presupposes that nature can be described in simplified form and with a known degree of accuracy by the text.

Measurement results may confirm the hypothesis, contradict it (then the experiment must be repeated) or replace the hypothesis, or remain ambiguous (then the experiment could be repeated with greater accuracy). In the example of light, the elementary semioses converged into a single immediate semiosis process (Figure 4, on the right). Here, the referent is, for example, the phenomenon of light refraction, whose representamen is the property of light refraction, and the interpretant is a pattern of values describing refractions—for example, refractive indices. Analogously, the individual case of immediate semiosis can be treated through the property of reflection, etc. These can be combined into a holistic process of immediate semiosis (Figure 4, on the left), where the referent is, for example, the light of a specific light source, the representamen a physical quantity describing the properties of the phenomenon, and the interpretant the concept of refraction as a universal phenomenon (phenomenal concept).

Dynamic PCP semiosis is related to the conception of a physical object. The understanding that objects primarily exist and have properties was carried into physics from the common context. The properties of objects manifest in phenomena, and relations between objects manifest in the interaction of properties. This is also consistent with language, where declarative sentences include a subject (object) being discussed and a property or classification attributed (predicated) to the subject.

Although only properties can be measured, PCP presupposes that it is easiest (in both common-sense and mathematical terms) to treat properties that occur in a complex way as belonging to some underlying entity (a *substance*, as already described by Aristotle (*Cat.* 1b25–2a4). This entity can be considered the object under study, even though the object itself is not directly empirically cognizable. The use of objects as substances in physics only became problematic with the introduction of quantum mechanics. However, at the dynamic stage of PCP semiosis, other container linking properties can be chosen instead of the object (substance)—an event or a process, for instance. In such a case, it is more correct to speak not of the existence of physical objects, but rather of the occurrence of events, in the description of which it may be pragmatically reasonable to use physical objects as means of description. It seems that for a substantial object, the existence condition C_X defined before formula (2) is satisfied for PCP, but not on an ontological level.[14]

The referent dR^{P}_{k} of an individual case of dynamic PCP semiosis (Figure 5) as an experienced individual object manifests when the experiences of immediate phenomena are combined. Its representamen is the properties of the individual object, and the interpretant is the concept of the individual object (objectual concept). Since physics primarily seeks relations between universals rather than particulars, objects are treated as an element within the set of objects of their kind—often, a fuzzy set[15]. Possible properties of individual objects converge into general properties dE^{P}, and individual concepts converge into the concept of physical object (universal) dT^{P}. Based on the context, it is assumed that the experienced individual objects converge into the experienced physical universal (or fuzzy universal) object dR^{P}.

[14] It might be worth noting that, within the context of the existence conditions described above, the ontic problematicity of substantial objects highlights a core principle of semiosis: the relations between the poles of any act of semiosis are context-interdependent, with the reciprocal interaction mediated by the semiotic field. Consequently, the truth conditions of any claim—including existence claims—necessarily depend on the constituent elementary semiotic processes and, by extension, on the surrounding context. Therefore, a primary existential condition for meaning or truth is its situatedness within a specific viewpoint—the pragmatically efficient locality within the semiotic field. A formalized description of this model, however, exceeds our current scope, as would a more detailed discussion of the applications of formulas (2) and (3).

[15] A single object or subset of objects may satisfy the criterion of belonging to a fuzzy set with a certain degree of truth. The value of the degree of truth is a real number in the interval [0;1], and in order to fix the value, the properties that are relevant in the given context must be highlighted in the description of the set, together with their weight relative to other properties. For example, a brown dwarf may emit radiation like a star during a certain period, but it is unable to initiate thermonuclear reactions, and the degree of truth of the subset of brown dwarfs belonging to the set of stars must be assessed on the basis of the approach used.

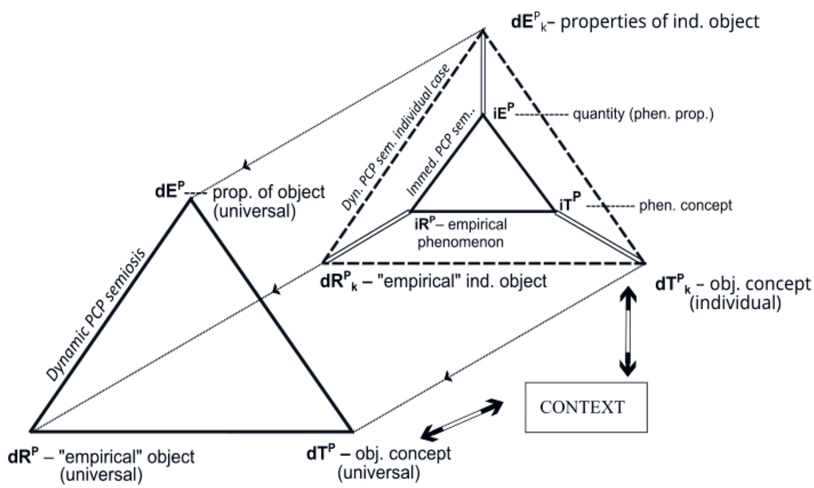

Figure 5. Dynamic PCP semiosis presents the formation of the measured properties attributed to an object into a concept modelling the object. Since the object is not directly measurable, the word "empirical" in the figure is placed in quotation marks. Each pole of dynamic semiosis corresponds to a set of poles of immediate semioses. The dashed triangle in the figure represents an individual case of dynamic semiosis as a collection of immediate semioses.

The most influential aspect of context in the dynamic semiosis stage manifests in the choices made when constructing concept modelling physical objects (or other bearers of properties), which take into account the properties considered relevant in the given context. PCP presupposes that the models provide simplified representations of real-world entities within the prevailing paradigm.[16]

In the example related to light, all observed empirical phenomena of a specific light source, such as refraction, reflection, etc., converge into the referent of the individual case of dynamic semiosis (Figure 5, on the right). The representamen is the set of properties of light from the specific light source, and the interpretant is the conceptual model of that light source. The individual cases converge into the holistic process of dynamic semiosis (Figure 5, on the left), where the referent is the light of any light source, the representamen is the set of its empirical properties and the interpretant is the conceptual model of light as a universal.

[16] No less relevant is its function in dynamic semiosis as a feedback loop which enables a crucial aspect of science as a social epistemic practice: the effective, critical accumulation of knowledge across human generations.

In the eighteenth century, both aforementioned models were consistent with observations. Although evidence began to accumulate in favor of the wave model—Young's double-slit interference experiment being a notable example—it was not taken seriously due to Newton's authority in PCP. The situation changed when Fresnel's treatise, based on the wave model, was nominated for the French Academy's prize. The mathematician Poisson showed that according to the wave model, a bright spot must form in the center of the shadow of a spherical object, which seemed absurd. Yet, the predicted spot was observed in an experiment conducted in 1819, providing decisive evidence for the wave theory (see Gribbin, 2002, chapter 11). In semiosis processes, this episode shows the dependence of the interpretant on the context, which can be corrected if there is a competing theory confirmed by an *experimentum crucis.*

A limitation of dynamic semiosis is the unobservability of its referent—the empirical object. The existence of an object bearing properties, that is, a substance, seems natural for both linguistic and historical reasons in science, and it was also consistent with the worldview of classical physics. Einstein's (1905) treatment of the photoelectric effect defined light as a flow of photons, which at the same time has wave properties. Since then, the understanding gained traction in PCP that objects can belong to a set of entities that PCP arbitrarily exports from the universe of means of understanding the world into reality.

The referent $fR^P{}_k$ of an individual case of **final PCP semiosis** (Figure 6), as a relation derived from experience, manifests when the connected property values of relevant objects are combined. Its representamen is the law of physics expressed in the language of mathematics, and the interpretant is the physical principle, formed from laws describing the model objects against the paradigmatic background of PCP. The manifestation of relations is usually measured in various situations. These converge into an empirical relation fR^P, whose representamen is a physical rule or law or set of laws in the language of mathematics, and the interpretant fT^P is a physical principle or set of principles.

The terms 'principle' and 'law' are also used synonymously in physics, but 'rule' usually carries the narrowest meaning and 'principle' the broadest meaning. A law is describable by one equation, whereas a principle can be presented by several equations for different parameters. For example, Heisenberg's uncertainty principle can yield an inequality for momentum and position in one case, and for energy and temporal duration in another. A principle relies primarily on the paradigm. Even when a principle seems to restate a law of physics, it is extended beyond the limits of mathematical validity. For example, the law of conservation

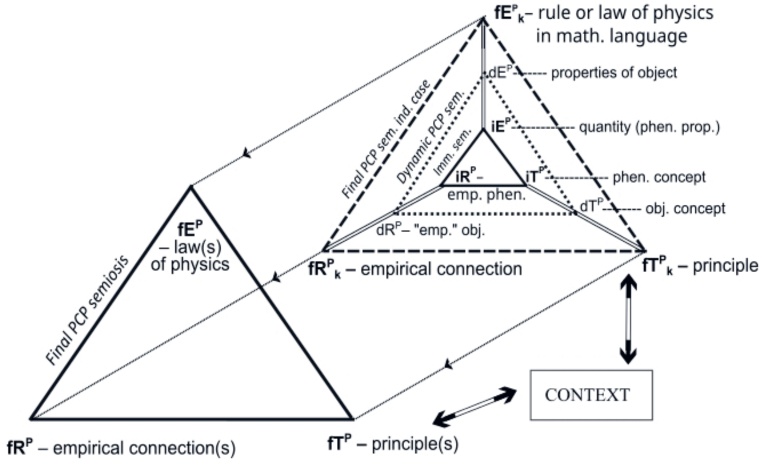

Figure 6. Final PCP semiosis. In the individual case of the process, the referent is the empirical relation between empirical phenomena, where the phenomenon is a manifestation of some interaction, whether its carrier is an event, objects or something else, or perhaps such a carrier does not exist at all (Figure 6, on the right). Its representamen is a physical rule or law, and the interpretant is a physical principle within the prevailing paradigm. Empirical relations identified in various situations converge (indicated by the thin slanted line) into a generalized empirical relation or set of relations fR^P, whose representamen is a physical law (or a set of laws) expressed in the language of mathematics, and the interpretant fT^P is a physical principle (or a set of principles).

of energy does not hold when postulating the beginning of time, whereas the corresponding principle by the same name might. Law and principle are related: an empirical rule becomes a law of physics when it holds for all objects of the same category (in other words, for a universal) and is grounded in some principle valid within a given paradigm (see, e.g., Baird, 2024). A contradiction between objects or relations and the paradigm may give rise to new principles and a paradigm shift.

An empirical relation is not directly measurable but is mathematically derivable from multiple measurements. Since the relation is derived from measured or observed phenomena, the addition of physical objects is not necessary, and the dynamic semiosis stage may be reinterpreted differently or bypassed altogether. Therefore, the triangle of dynamic semiosis is shown with a thick dotted line in Figure 6. Even in the case of a relation, the question arises as to which extent does it correspond to the empirical, because the form of the relation and even its existence in the empirical universe depend on the chosen mathematics and the context of its application. For example, in the context of special relativity, the rules for summing numbers prove insufficient when adding large velocities.

For example, in the individual case of final semiosis for light, the fact that the electric and magnetic fields are related and that their change creates electromagnetic waves emerged from the works of Faraday. Its representamen is the rule of the relation between these fields in the language of mathematics in individual cases. Rules apply in the case of a changing field, the interpretant of which is the principal conception of electromagnetic waves in a vacuum.

In the general case of final semiosis (Figure 6, on the left), the identified relations converge into a universal. Their representamen is the set of Maxwell's equations—a law (or laws) of physics expressed in the language of mathematics—and the interpretant is the principle of electromagnetic waves, which travel at a constant speed through a vacuum, where the speed is independent of the reference frame. Observation confirmed that the speed of light coincides with the speed of the electromagnetic wave, which led to the hypothesis that light is a part of electromagnetic waves, and this, in turn, could be confirmed with new observations. Einstein understood the essence of the principle and built special relativity on it, which in turn changed the paradigm in physics. Time and space acquire a completely new meaning as spacetime. The speed of light has a special meaning in today's PCP, and this is reflected in its adoption as an absolutely precise unit of measurement.

In **total PCP semiosis**, empirical relations and conditions are combined into an empirical universe, laws of physics into a theoretical universe and physical principles into the PCP universe model (see Figure 7).

The referent of total PCP semiosis is also a set, potentially a fuzzy set. In the case of the referent, the existence of an empirical source is assumed, and this is usually considered to be the real material universe. In the case of the representamen, the existence of the source of mathematics is acknowledged; its origin is unclear. According to some treatments, it also originates from the real universe.

In the total semiosis stage, the paradigm and context play a particularly important role, and it can even be considered the maintainer of the paradigm, where the paradigm exhibits inertia with respect to new data and new theories. For example, the study of light laid the foundation for the emergence of QM:

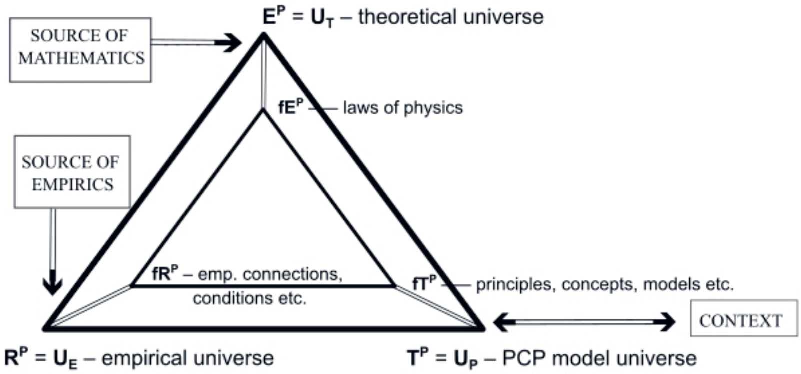

Figure 7. Total PCP semiosis. Total semiosis depicts the representation of the empirical universe $R^P = U_E$, which is connected through the theoretical universe $E^P = U_T$ as the representamen with the interpretant—the PCP model universe $T^P = U_P$. The description of the universe as a pole of semiosis combines all final poles of the same type (indicated by a double line).

the photoelectric effect as the referent, the quanta introduced in theory due to the ultraviolet catastrophe as the representamen, and the resulting principles as the interpretant, which uphold today's PCP worldview of a quantum universe.

All stages of PCP semiosis can also be presented together (Figure 8). The distinction between the five stages of PCP semiosis, however, remains useful, as the context and sources influence each stage of the semiosis process somewhat differently.

In physics, the empirical universe is treated as a collection of influences from the real universe, fixed through observation (including measurement). Classically, the observer is a person who receives and processes information about the world (nature). Such a person has the ability to receive, store and use information, the ability of free choice and the ability to associate the received information and draw inferences about the world. An ideal observer does not affect what is observed and provides precise observation data. Relativity theory emphasizes that the observer includes a reference frame, and it is not possible to define any preferred or "universal" reference frame. Quantum theory introduced a significant change: the observer is always part of the system because observation changes the system. Observation, however, may be interpreted as any interaction between an isolated wave function and the external world, which causes the wave

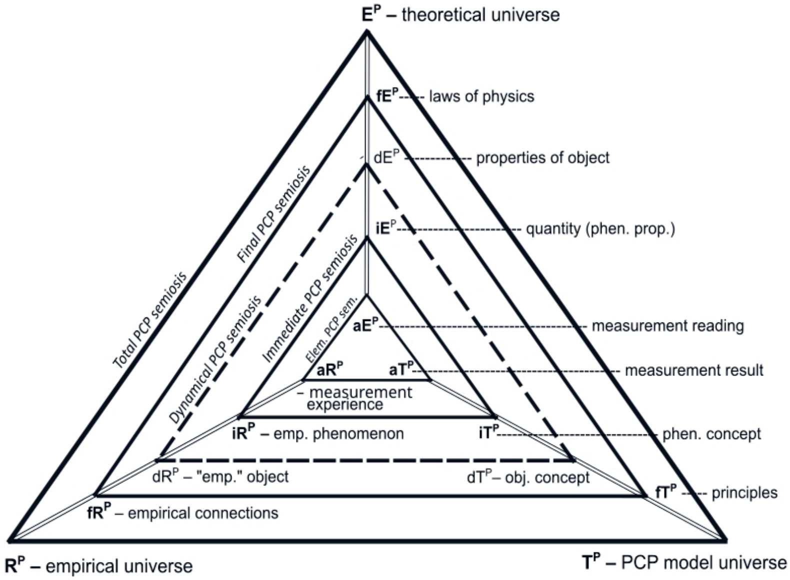

Figure 8. Overview of PCP semiosis. Each triangle represents a semiosis event, the double lines between the triangles indicate the stages of the semiosis process. The inner triangles represent sets of multiple semiosis events. The dynamic semiosis stage is represented by a dashed triangle because the variability of its descriptions seems to distinguish it from the other stages.

function to collapse. That is, the observer does not have to be a conscious being; such an observer could be called a measurer. A conscious measurer may also make purposeful choices in addition to describing. The question of the existence of choice and the ability to make a choice can be important in both the physical and subjective and social contexts.

Choice is an action that results from the decision of an individual agent or group among multiple possibilities. PCP consists of people who, in acting in the life-world, also consider personal and social aspects.

Observers' choices change models, individuals' choices may change theories, acts of action and thereby reality. However, as it stands, paradigmatic changes in the PCP worldview cannot be ruled out:

- Choices may change reality by influencing the laws of nature or creating universes, for example, the many-worlds theory (see, e.g., Carroll, 2020);

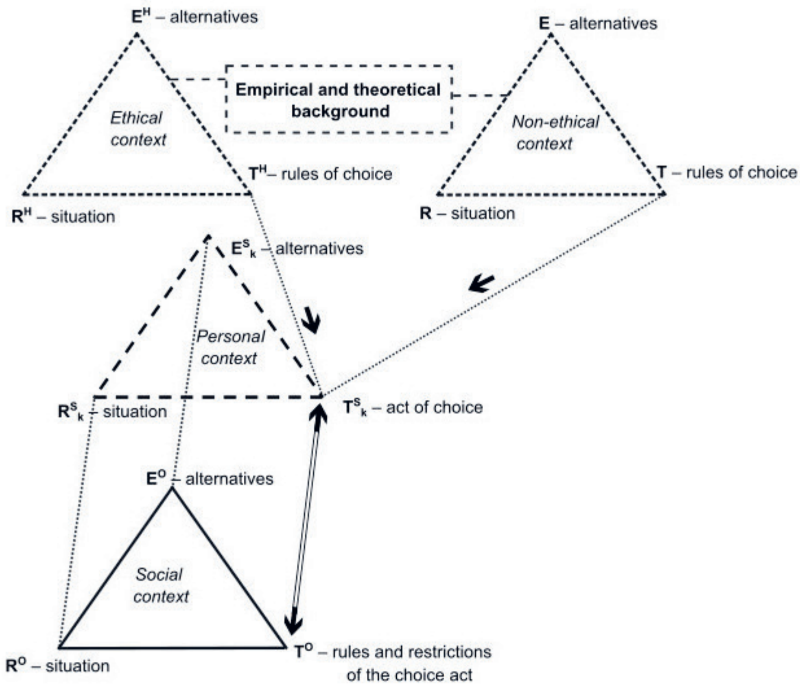

Figure 9. Individual (agent) choice semiosis. The ethical and non-ethical aspects of choice are marked separately, and the person's "life-world" experiences must also be taken into account.

- The hypothesis of the existence of a final cause must be taken seriously (see CP 6.101; Smolin, 2006; Anastopoulos, 2025);
- Unconscious or even supposedly inanimate entities make choices and are capable of learning (see Stern *et al.*, 2020; Ball, 2025);
- Conscious phenomena, such as a primary consciousness field (Keppler, 2025), may occur in reality, and individuals may be able to communicate with it.

We therefore examine whether the semiotic method could help PCP understand what is happening in the real universe, considering the possibility that the real world does not have to be reducible to a physicalist base structure.

3. Physio- or natural semiosis

The external sources of the PCP universe are mathematics and empirics. In studying the sources of empirics and mathematics, the researcher faces the danger of imagining that some of the tools they use to understand the world are themselves part of the world. For example, the idea that there is a "true" language leads the researcher into magic and sorcery. History shows that physicists are in danger of leaning towards vulgar materialism and mathematicians towards vulgar Platonism. For example, Heisenberg (2007 [1958], p. 32) noted: "We have to remember that what we observe is not nature in itself, but nature exposed to our method of questioning."

According to Kant, we need reference points to understand the world. These cannot be directly experienced but they make it possible for us to experience anything at all. For example, self-consciousness or space or time are not objects of experience but preconditions for experiencing objects. Without a critical attitude, these become distracting metaphysical prejudices. Antinomies—that is, contradictory theses that do not exclude each other—give notice of errors. This indicates a situation in which the subject of the thesis itself is not real but is imported into reality from the world of concepts.

Egginton attributed to Kant the understanding that there are principles that hold for

> being like us, whose basic form of existence was to be located in space and time and limited in what it can see and know. For while what we say about the world may never be universal, necessary, and true, we nonetheless can derive universal, necessary, and true statements from the very faculties that allow us to experience the world. For this to happen we must presume a unified subject, even though we cannot grasp it as an object, operating in a unified space-time whole, even if we cannot grasp that as an object either. We presuppose those unified substances as if they were objects of cognition for an eternal being, but then accept that they are not ours to know, that we are fundamentally limited to representations of that whole in space and time. And it is those representations we study when we do science, not the fundamental nature of the world itself. (Egginton, 2023, p. 112).

Above all, the tendency to believe that we speak of the real world, rather than a worldview, must be subjected to criticism; only then does the possibility of, and readiness for, a way out arise. From the PCP perspective, the most powerful tool for expanding the limits of human perception is modern physics, whose language is mathematics. However, in describing reality, help may also come from humanity's earlier achievements, for instance in philosophy and theology; relativity theory and QM were also created with the aid of philosophy. One aiding technique may also be the use of semiosis in the form of natural semiosis, which, according to Deely (2005), presupposes that the action of signs operates in the physical world even without organic matter. Who or what could be the carrier of the interpretant in natural semiosis? Peirce connected the carrier of the interpretant in semiosis with purposeful causality. As semiotics developed, it was extended from human semiosis versions to biosemiotics; yet even biosemioticians have spoken out against natural semiosis.

Kull (2023) argues that semiosis minimally presupposes arbitrariness, and that arbitrariness presupposes choice. Accordingly, he rejects extending semiosis to purely physical processes (Kull, 2023, pp. 65, 67).

Avoiding the problems of defining and structuring semiotics as a research discipline, we focus below on the question of whether the idea of natural semiosis can be fruitful in understanding the connections between the natural universe and the PCP universe. Essentially, the natural semiotic view refers to an entity that interprets and uses information.[17] The most general objective conception of this unit is the autonomous agent (Kauffman, 2000, pp. 52–53). An autonomous agent is a physical unit capable of maintaining thermodynamic work cycles to maintain its existence according to internally determined goals. The concept of an autonomous agent can be extended to any functional entity that operates according to its nature (for more detail, see Herrmann-Pillath, 2021). To avoid confusing semiosis operating in physics with semiosis in the real world, we use the clearly distinguishing terms 'PCP semiosis' and 'natural semiosis'.

The most common position in physics seems to be the realistic one, which could be described as the principle that reality manifests quite correctly (within uncertainty) through the empirical universe, and this allows something true to be stated about the real universe as well. We start from this assumption for now, and in light of the results, will discuss how justified such a principle might be.

[17] Information theory only began to develop as a useful method when Shannon (1948) abandoned the requirement that information belong to some form of consciousness. Similarly, in the case of natural semiosis, one may abandon the requirement that the bearer of meaning be conscious or even alive.

Thus, it seems that at least some elements of physics correspond to elements existing in the real world. The existence of entities, natural kinds and laws of nature is usually assumed; one variant is presented in Table 1.[18]

Table 1. Hypothetical correspondences between elements of physics and the real world.

Physics (U_P)	**Correspondence in reality (U_N)**
Theoretical and empirical world	Real world
Phenomena	Influences
Individual objects, quantities, values	Patterns of events, entities
Universals (general objects)	Natural kinds
Laws of physics	Laws of nature

In physics, an attempt is made to treat such empirical experiences that might have a counterpart in the external real world. During the study of PCP semiosis, we distinguished five different stages of empirical experience; initially, it seems reasonable to try to correlate each of them with an analogous stage in nature, which could be imagined as stages of natural semiosis.

Elementary natural semiosis connects the individual interaction, as the referent aR^N, with the representamen as the emerging effect, marked by one interaction effect aE^N, and the interpretant is the resulting effect aT^N realized from the set of possibilities allowed by the context—something that has been created, disappeared or changed (Figure 10).

For example, in an excited hydrogen atom, an electron jumps to a lower energy level, thereby releasing a light quantum—a photon. The referent is the interaction between the electric field of the atomic nucleus, the electron and the photon; the representamen is the change in the electron's state and the emission of the photon; and the interpretant is the result realized from the set of possibilities allowed by the context (rules, conditions, limitations)—that is, a photon was created and the electron's energy level changed. Unlike PCP semiosis, we do not have, by assumption, direct access to the interpretant of natural semiosis, but we can only have theories about it. For example, let us take Neukart's (2026) theory, according to which spacetime is quantified, every unit in it stores information about interactions and temporal order arises from the irreversible accumulation

18 The existence of real objects and their real properties is also often assumed, but it became genuinely questionable only after the creation of QM.

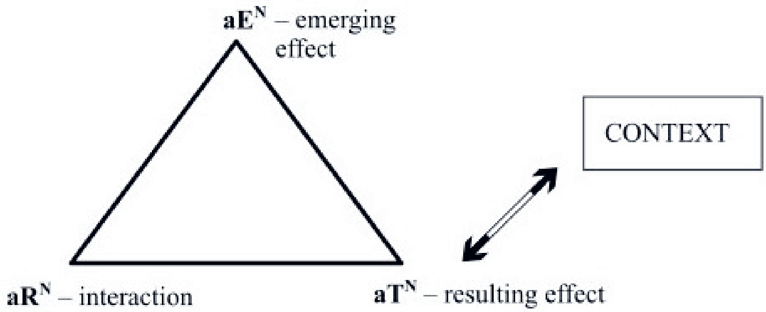

Figure 10. Elementary natural semiosis depicts one emerging effect of interaction as the representamen, and its interpretant is the result that emerges based on the context. The most influential aspects of context in this stage are the limitations and conditions for the occurrence of the interaction.

of information traces.[19] On this basis, the interpretant is related to information about how such an interaction occurs and what rules it is subject to.

In the individual event of **immediate natural semiosis**, elementary interactions converge to manifest as an active influence iR^N_k; its representamen iE^N_k is an occurring influence and its interpretant is the state of that influence iT^N_k (Figure 11). The generalized influence as a whole unit iR^N manifests through the convergence of manifestations (thin slanted line). Its representamen, the set of properties of the generalized influence iE^N, manifests through the combination of its different occurrences (thin slanted line). The generalized influence is a universal, a representative of a natural kind of its type; its interpretant iT^N is the state or set of states of the generalized influence.

For example, excited hydrogen atoms emit photons of different energies in different cases, which together yield a set of photons with fixed energies corresponding to the set of electron energy-level changes. This influence is the referent of the individual case of immediate natural semiosis, whose representamen is the hydrogen line spectrum, and the interpretant is the set of energy levels of hydrogen atoms, which results from rules defined by the context. The referent of the general case of immediate semiosis is the set of all possible emitted photons of all excited atoms along with the set of energy level changes. The representamen is the emission spectra of the atoms, and the interpretant is the set of energy levels of the atoms, which results from rules determined by the context.

[19] Neukart's theory is one of many that, if followed, require a reassessment of our understanding of the semiotic boundary and of the current limitation of learning ability to living beings.

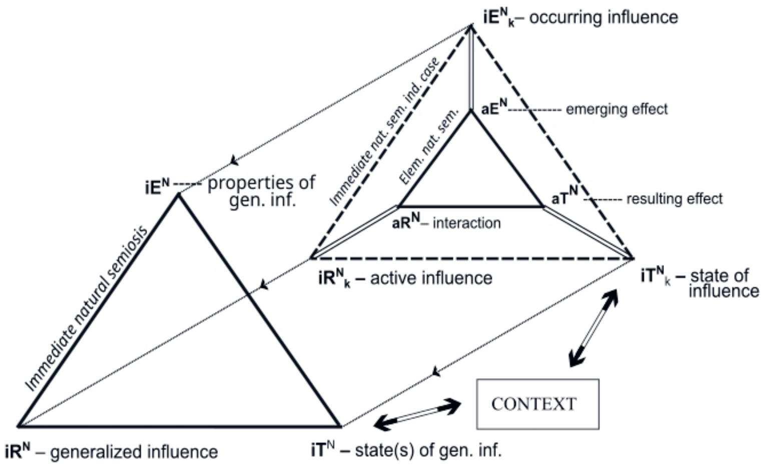

Figure 11. Immediate natural semiosis connects the influence to its state through its properties. The most influential aspects of context in this stage are the regularities, conditions and limitations of the influence's occurrence.

In the individual case of **dynamic natural semiosis**, influences converge into an individual event dR^N_k, whose representamen is a natural entity and the interpretant is the set of rules and limitations that allow the entity to manifest through the event (Figure 12). Similar events converge into some fuzzy set, which represents the collection of events as a universal (or fuzzy universal), bringing forth the referent dR^N of dynamic semiosis. Its representamen is a fuzzy set of certain entities or their relevant collection. The interpretant of the representamen is the set of rules and limitations dT^N, which determines how sets can participate in events through members and to what extent a specific entity is subject to the code applicable to the universal as a whole.

For example, the emission or absorption of a photon occurs as an individual event, its representamen can be the atom with its change of state and the interpretant is the set of rules and limitations that manifest through the control of the event's occurrence. The general case of natural dynamic semiosis is, for example, the event of photon emission or absorption as a universal, its representamen can be atoms as property bearers and the interpretant is the set of rules for photon emission or absorption, which, so to speak, notices and controls the occurrence of the event.

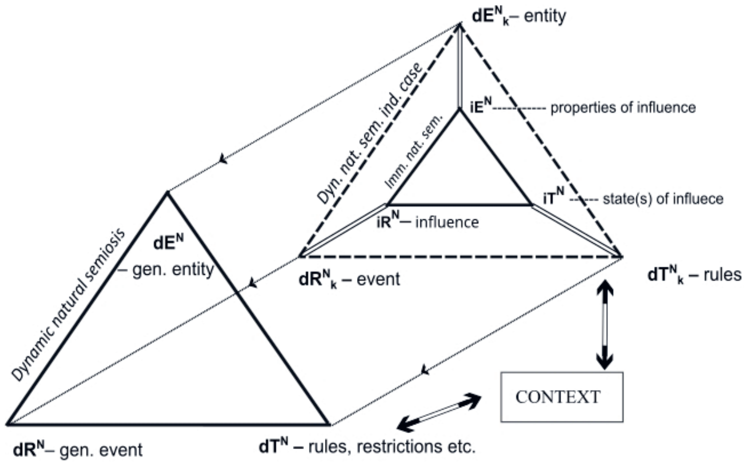

Figure 12. Dynamic natural semiosis connects the progression of events through the manifestation of rules and limitations via (natural) entities. The most influential aspects of context in this stage are the laws of nature and boundary conditions.

In the individual cases of **final natural semiosis**, events are sequenced into individual processes fR^N_k, the participants of the process are marked by natural kinds[20] and the interpretant is the set of laws of nature, which determine whether specific natural kinds fall under the rules and limitations determined by the laws or not (Figure 13). Since a natural kind represents a fuzzy set, the rules may also apply partially. Individual processes can converge into a set of interrelated processes forming a generalized process as the referent fR^N of final natural semiosis. Its representamen is the relevant set of natural kinds fE^N, and the interpretant fT^N is one or more laws of nature along with limitations and conditions.

For example, the process may be the absorption and emission of photons in atoms, which is also the referent of the individual case of semiosis; its representamen is the set of atoms as a natural kind and the interpretant is the set of laws of nature that "notice" and govern the process. An example of the general case could be the absorption and emission of photons as a universal, its representamen is any absorbers and emitters, including atoms, and the interpretant is the set of laws of nature and limitations controlling the processes.

[20] Further on natural kinds and the laws of nature, see Riggs (1996) and Hildebrand (2023).

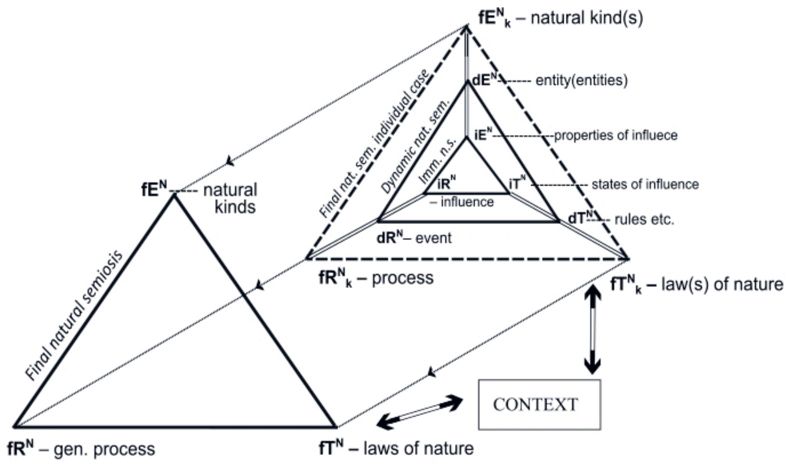

Figure 13. Final natural semiosis. Events are sequenced into processes, their representamen is the set of natural kinds as universals, and the interpretant is the set of laws of nature, which determine to what extent entities and processes are subject to rules and limitations. The context for this stage is the real universe.

In **total natural semiosis**, all natural processes are combined into the real universe. Its representamen is the set of all natural kinds, and their existence creates or discovers the set of all laws of nature—that is, the natural code (see

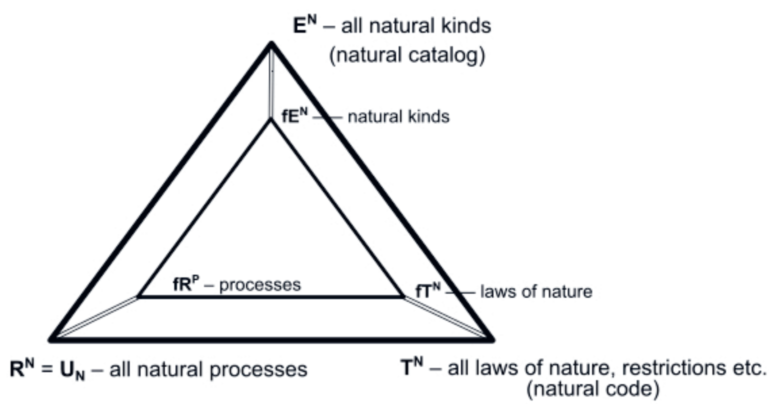

Figure 14. Total natural semiosis. Total semiosis is obtained by combining all corresponding elements of final semiosis (double line), where $R^N = U_N$.

Figure 14). Total semiosis connects the real universe through natural kinds as the representamen with the set of all laws of nature, whose sense is ambiguous.[21]

Due to the lack of direct access, it remains unclear to what extent our described natural semiosis captures nature and to what extent it is a reflection of our theories. Methodologically, it can be treated as a model of reality that can be adapted according to changes in our knowledge.

All stages of natural semiosis can also be presented together (Figure 15).

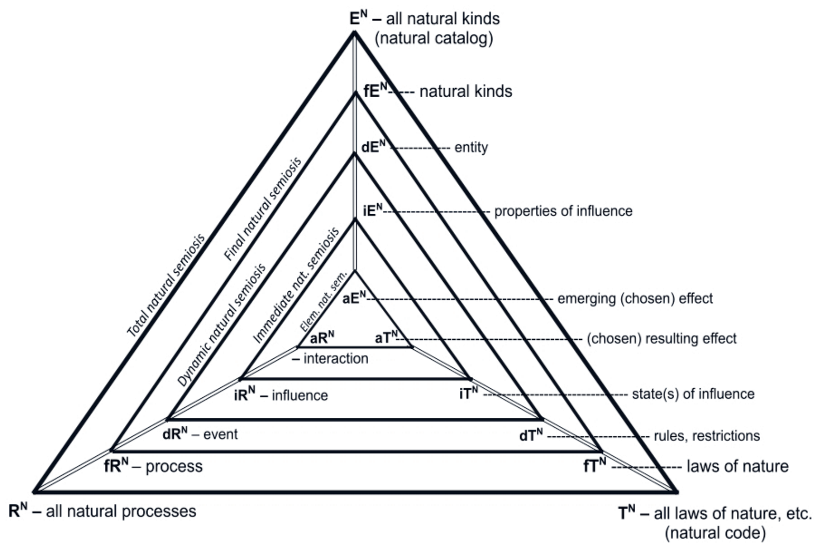

Figure 15. Overview of natural semiosis. Each triangle denotes a discrete semiosis event, while the double lines indicate the transitions between the stages of the comprehensive semiosis process. The nested structure illustrates a recursive logic: each inner triangle is a set of sub-processes that mirrors the semiotic architecture of the encompassing level.

All processes form the real universe (nature) $R^N = U_N$, whose existence as the object of study in physics is presupposed in physics. All elements are real and independent of subjects, except for the events created by the subjects. Table 2 presents the meanings of the poles of natural semiosis and PCP semiosis in the five stages of semiosis and Figure 16 demonstrates the relations between the poles of the total stages of natural semiosis and PCP semiosis.

[21] We shall discuss one possibility below in the section on theosemiosis.

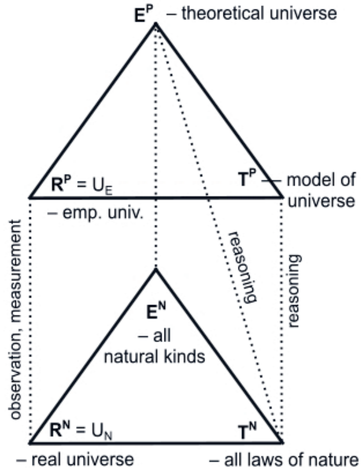

Figure 16. Relations between the poles of total natural semiosis and total PCP semiosis. The catalog of all natural kinds is E^N and the code of all laws of nature is T^N. Dotted lines mark the relations.

Table 2. Comparison of natural semiosis and PCP semiosis stages.

Semiosis	R^N – nature	E^N – catalog	T^N – code	R^P– experience	E^P – theory	T^P – model
Elementary	Interaction	Emerging effect	Resulting effect	Measurement experience	Measurement reading	Result
Immediate	Influence	Properties of influence	State of influence	Empirical phenomenon	Quantity	Phen. concept
Dynamic	Event	Entity	Rules, restrictions	Empirical object	Properties of object	Obj. concept
Final	Process	Natural kind	Law of nature	Empirical connection	Law of physics	Principle
Total	U_N	All natural kinds	All laws of nature	U_E	U_T	U_P

The comparison of PCP and natural semiosis performed in the above manner is heavily biased towards physics, but by examining it, problematic circumstances might emerge somewhat more clearly than in the dyadic treatment.

One basis for the natural semiosis model is Peirce's pragmaticism and Mach's thesis that the goal of science is to create an accurate description of all of nature.

Observers should ensure the consistency of the laws of nature and the laws of physics within uncertainty. Observers and PCP look for mathematical relations in nature. The simplicity and idealization of the laws, both in terms of relations and entities, ensure the storage and transmission of information by the fewest possible means. Wheeler (2018) presents three pieces of evidence in support of this explanation:

- The discovery of scientific laws can be viewed as the solution of algorithmic problems;
- Scientists regularly use laws to unpack datasets;
- Laws function as algorithms in science.

The laws of physics are false and exceptional in their simple form, but true and unexceptional when grounded in *ceteris paribus* conditional assumptions.[22] For example, the law that the period T of a pendulum depends only on the length l of the pendulum for a fixed gravitational acceleration

$$T = 2\pi\sqrt{\frac{l}{g}}$$

does not hold in its simple form, but becomes applicable when we take into account the fact that the shape of the pendulum is not a point mass at the end of a massless string, but that it has a shape with some mass distribution, etc.

The second column of Table 2 (nature) deals with the problem of what is real. In the case of physical quantities, it was assumed during the era of classical physics that material substances exist in reality and carry properties. After the creation of quantum theories, this is no longer obvious. We also do not primarily ask what is true but rather what is happening; and in answering this question, we rely on Whitehead's (1929 [1978]) process philosophy. We presuppose that processes occur, whose structure consists of ordered sets of events. Events manifest as influences, in which elementary effects caused by interactions between properties can be distinguished and the question of the carriers of the properties remains vague.[23]

22 For example, the *ceteris paribus* version of the simple law "Every F is G" is: "If all else is equal, then all Fs are Gs".

23 In macroscopic physics, it is usually possible to continue using models of material substances and external fields, whereas quantum theories tend to favor the use of various fields, some of which, such as probability fields, are more mathematical than physical in nature, though they still have a real effect.

The third column of Table 2 (catalog) relies on the controversial idea of natural kind, for which it is necessary that its members share certain common (natural and essential) properties, form a kind and hierarchy, and the natural kind should participate in the laws of nature[24] and allow for inductive conclusions. However, it is questionable, for example, whether our imagined natural kinds are truly natural and real units, and whether they have essential properties (essences)? Natural kinds are one set of tools for which we may unintentionally export structures necessary for explaining the world into the real world.

In the fourth column of Table 2 (code), only the result is related to what is empirically experienced. Access to the state of the influence is already more theoretical than empirical, and each subsequent row contains increasingly more theory and less empirical data. Everything that is not empirically experienced but whose properties and also existence or occurrence in the real world are derived by PCP could be divided into at least two classes:

(i) The existence of an entity or the occurrence of an event is inferred from observational data based on mathematical (and logical) reasoning;

(ii) The presupposition of the existence of an entity or the occurrence of an event is necessary to explain the meaning of observational data and place it in the PCP model universe U_P.

In the first case, it must be considered that the foundations of mathematics and logic are no longer indisputable (as they were in Kant's time); a choice must be made as to which mathematics and logic we use, and then we can study the results resulting from the application of the selected complex. We choose intuitionistic mathematics and paraconsistent logic.

In the second case, following Kant, three levels may be distinguished: (1) self-consciousness, which distances the observer from the object of observation and structures the data, thereby making observation possible at all; (2) time and space, on the basis of which the data are organized and (3) categories of thought supported by the paradigm—concepts.

Is the universe $U_{M,}$ containing the objects of pure mathematics, entirely derivable from the material universe? (1) If the answer is "yes", then mathematics is a

[24] By abandoning natural kinds, we should also abandon physics in its current form, because the laws of physics would then break down into empirical rules and principles would become mere metaphysical speculations. This point of view does not fit the pragmatic position of our article, and we will not discuss it here, although it may be meaningful in some other context.

natural science, except that the objects of mathematics present completely abstract aspects of reality, which can be used, among other things, as tools of the language of physics. In this case, mathematics has the same source as empirics. (2) If the answer is "no", then a "third world" of abstract objects may be postulated in the Platonic and Popperian manner, in which U_{M} can form its own subset. In this case, philosophical and theological problems arise which, within the scope of this article, could only be sketched.

The search for general knowledge leads to questions about the nature of reality, which have traditionally been addressed mainly by theologians and philosophers. In the classical physics era, the rule "physicist, beware of metaphysics" could be followed, because Newton's metaphysical views were adopted both implicitly and explicitly. Attacking them seemed to have no practical value, because (1) they mostly seemed reasonable and (2) they justified themselves within the practice of the time. Religious scientists always had the opportunity to appeal to God, and atheists bowed to the "only possible" basic postulates about a material and eternally stationary universe. Although science grew out of theology and retained several theological understandings—for example, the idea of necessary and generally valid laws—science differed from theology primarily due to its rational content. Theology and philosophy have been far more beneficial to science than is commonly believed. (Allen and Marcacci, 2025)

Nevertheless, science has utilized the concept of God as an explanatory heuristic, serving as a model for the omnipotent and omniscient observer (Maxwell, 2010, pp. 8ff). If, for example, one wishes to claim that there is a specific number of molecules in a closed container, but no one can count them, one may say that only God knows their exact number. In the age of conscious fear of religion in Nagel's (2003, p. 127) sense, there is no need to fear the adoption of theological thought patterns in science, provided that it justifies itself and avoids attributes associated with a specific religion.

Above, we approached the set of laws of nature applied in a specific natural semiosis as the interpretant of the set of processes in question. If the need arises to use the set of all possible laws of nature, we could borrow from theologians the concept of Immanent Absolute (IA) (see Figure 17). The set of all laws is always present and operates everywhere wherever something happens. Such properties also belong to the Immanent Absolute. IA can also be the interpretant for the physical universe, which is the space for the operation of all laws of

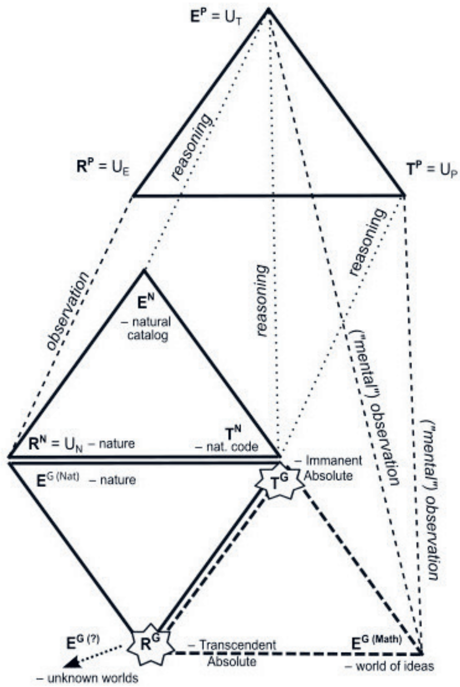

Figure 17. Total PCP, natural and theosemiosis. The model of theosemiosis presented here uses theological thought patterns but needs not have religious content. Any source of existence can be in the role of TA, and IA can appear, for example, in the form of a consciousness field, etc. There can also be more worlds, as marked by the dashed arrow.

nature.[25] However, this is made possible by the phenomenon that is the source of existence and of the laws of nature, and this corresponds to the Transcendent Absolute (TA) in Plotinus's sense—the ONE, which makes existence possible and is the source of reality (Plotinus, 1984). We obtain a model of theosemiosis, in which the referent is TA, the representamen is the real world of ideas and the interpretant is IA. However, in Plotinus's view, TA is also the source of the world of ideas, and thus another semiosis arises between TA, the world of ideas and IA. Theosemiosis has primarily a methodological role here.

The universe may be intertwined with semiosis. The biosemiotician Kull (2018) wrote, rather aptly, that life consists of learning from choices, and semiosis

[25] Our simplified model of IA only presents the use of ideas and does not present any version of theology, in which IA may have much more complex content.

describes learning. Choices teach one how to make new choices. However, it does not follow that semiosis is limited to life, as hints of choice and learning ability arrive from physics outside living beings (Stern *et al.*, 2020; Ball, 2025; Neukart, 2026). If semiosis is learning, then the boundary of semiosis could be moved further away from life, for example, as follows:

- In natural semiosis, the world learns to exist;
- In biosemiosis, entities learn to exist in the world;
- In rational semiosis, rational entities learn to know and adapt the world;
- In theosemiosis, the world learns to change itself and to create worlds.

It seems that science is still far from having exhausted the capabilities of Peirce's semiotics, and the current paper could only hint at them.

Conclusion

Problems in natural science can also turn out to be philosophical and theological problems, and vice versa. Drawing on Peirce's view of semiotics as the logic of science, we have proposed a unified semiotic framework that bridges the methodological gap between the cognitive processes of the personified community of physicists (PCP) and the underlying dynamics of natural reality. By mapping the five stages of PCP's epistemic semiosis onto a model of natural semiosis, we have argued that the 'measurer'—whether human or inanimate—operates within a recursive triadic structure unlike the customary dyadic view in the natural sciences. The comparative analysis enables us to identify cases in which epistemic constructions are inadvertently projected onto reality itself.

This inquiry leads us to pragmatic conclusions regarding the situatedness of physical and semiotic existence: the truth conditions of any claim are inextricably bound to the pragmatically efficient locality within a semiotic field. Our model suggests that what physics traditionally labels as 'objective laws' are, in a semiotic sense, stabilized interpretants within a multi-layered process of natural meaning-making.

Furthermore, by introducing theosemiosis as a methodological boundary, we argue that the ultimate grounds of reality can be fruitfully modeled through the interplay of Immanent and Transcendent Absolutes. This approach allows for a coherent understanding of a universe that "learns to change itself", moving beyond the fallacy of misplaced concreteness. While formalizing the mathematical relationships between these stages and a detailed analysis of our model's further applications remain tasks for future research, this semiotic perspective offers a viable alternative to purely reductionist accounts of the physical world.

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