The Relevance of Phenomenological Analysis
Within Current Epistemology

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Abstract

This article is primarily concerned with the articulation of a defensible position on the relevance of phenomenological analysis with the current epistemological edifice as this latter has evolved since the rupture with the classical scientific paradigm pointing to the Newtonian-Leibnizian tradition which took place around the beginning of 20th century. My approach is generally based on the reduction of the objects-contents of natural sciences, abstracted in the form of ideal objectivities in the corresponding logical-mathematical theories, to the content of meaning-acts ultimately referring to a specific being-within-the-world experience. This is a position that finds itself in line with Husserl’s gradual departure from the psychologistic interpretations of his earlier works on the philosophy of logic and mathematics and culminates in a properly meant phenomenological foundation of natural sciences in his last major published work, namely the Crisis of European Sciences and the Transcendental Phenomenology (Husserl, 1962). Further this article tries to set up a context of discourse in which to found both physical and formal objects in parallel terms as essentially temporal-noematic objects to the extent that they may be considered as invariants of the constitutional modes of a temporal consciousness.

Keywords: disentangled state; holistic; impredicativity; intentionality; nonstandard theories; phenomenological reduction; temporal consciousness; transcendental ego; undecidable sentences.

1. Introduction

Phenomenology can generally be considered, on the one hand, as an evolution of classical continental philosophy, referring in particular to the various
nuances of subjective idealism originating in the German idealist tradition of the 18th-19th century (Kant, Hegel, Fichte, Schelling) and, on the other hand, as a philosophy (in the sense of a descriptive a priori science as E. Husserl wanted it) open to developments in the broader epistemological edifice of the 19th and 20th centuries. The latter view may be taken as associated in a definite sense with F. Brentano's and H. Lotze's theories pointing to a psychologistic reductionism of positive science in general and from a certain viewpoint with G. Frege's logical reductionism concerning mathematical foundations.

In the following, a phenomenologically motivated interpretation of certain key epistemological questions will be presented, given that the field of knowledge of phenomenology can be associated with that of epistemology insofar as the objects of epistemology taken as by-products of a process referring to the perceptual mechanisms of a subject can be considered as essentially phenomenal objects. As a matter of fact, a key part of Husserl's philosophical work was the phenomenological analysis of the experience, of judgements and of formal apophantics (e.g., in Logical Investigations, in Formal and Transcendental Logic, and in Experience and Judgment, cf. Husserl, 1984, 1974, and 1972, resp.), as well as the descriptive a priori analysis of temporal consciousness mainly elaborated in the Phenomenology of Inner-Time Consciousness (Zur Phänomenologie des inneren Zeitbewußtseins, Husserl, 1966). The phenomenological interpretation of logical laws, broadly conceived, distinguishes itself from psychologistic interpretations in that accepting as a lowest-level foundation of knowledge the pre-predicative (or pre-linguistic) experience grounding the knowledge in rem, it introduces moreover a special a priori relation we bear with things themselves which should not be regarded as solely a physical interaction though our sense organs. This a priori relation being essentially intentional in character may help provide a sound interpretation to the vexing epistemological question of the residuum left in the objectification of the phenomena of real world experience, these taken as presenting themselves originally ‘in front’ of a subject's embodied consciousness. More on this special kind of relation we bear with the objects of our physical or mental experience I will develop in the next sections.

It should not be left without notice, at this point, that E. Husserl completed his doctoral formation in mathematics at the University of Berlin
under the guidance of the famous mathematician Karl Weierstrass. He continued to do research in mathematics for several years and had ample knowledge of the developments in the mathematical foundations and set theory through his exchanges with G. Cantor, G. Frege and D. Hilbert. He had also the opportunity to engage in fruitful discussions with the founder of the intuitionistic theory in mathematics, L.E.J. Brouwer, during his visit to Amsterdam in 1912. It is indicative of Husserl’s mathematical background that two major works belonging to the earlier psychologistic stage of his phenomenological-transcendental philosophy are the *Philosophy of Arithmetic* (*Philosophie der Arithmetik*, Husserl, 1970) and the *Studies on Arithmetic and Geometry* (*Studien zur Arithmetik und Geometrie*, Husserl, 1983). One can note here that even though Husserl dealt in the Philosophy of Arithmetic with such basic mathematical concepts as the concepts of number and of multitude in a way that what is immediately given is restricted to what is concretely intuited and further susceptible to mental abstraction, yet in certain respects this early work bears the traces of a phenomenological-constitutional investigation (Hartimo, 2006: 328). Of course, Husserl’s strong mathematical background is not by itself a vindication of the relevance of phenomenological philosophy with pure logic, the foundations of mathematics and epistemology in general. In the next, I am going to discuss in some length the arguments that make phenomenological analysis relevant with certain fundamental questions of contemporary epistemology.1 Yet, it would be an omission to make no reference to certain phenomenology scholars who are adamantly opposed to any attempt of ‘naturalizing’ phenomenology and defend their position based mainly on Husserl’s earlier positions around the time of *Logical Investigations* (see: Ortiz-Hill, 2013: 79).

In any case, and independently of the intentions one can ascribe to Husserl himself on the matter, phenomenology as an eidetic-descriptive science cannot and should not be ‘sterilized’ from what underlies its overall scope and endeavour and this is the world of phenomena unfolding within the life-world of our experience. On this account one may refer, in particular, to Husserl’s views in *Cartesian Meditations* where the psychological origins of the ideas of

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1 Some original works on the relevance of phenomenology with current epistemology are: French (2002), Lurcat (2007), Tragesser (1977 and 1984).
space, of time, of physical things are reduced to transcendental problems of intentionality “which have their particular places among the problems of a universal genesis” (Husserl, 1960: 76). And further, the total science of the a priori, designated as the systematic unfolding of the all-embracing a priori innate in the essence of a transcendental subjectivity (and consequently in that of a transcendental intersubjectivity), would be the foundation for genuine sciences of matters of fact, for all a priori sciences without exception and for “a genuine all-embracing philosophy in the Cartesian sense: “an all-embracing science of the factually existent, grounded on an absolute foundation.” (Husserl, 1960: 155).

2. A review of the evolution of the epistemological edifice

We have already passed the second decade of the 21st century and the question of the content of scientific truth and its limits is more than ever in actuality given the galloping pace of development of cutting-edge technologies, of advancing physical and cosmological theories, etc. Yet, certain questions of depth are still pending even though one might say that they are posited in a quite vague epistemological context. For example, one may ask the following questions: Is there a need of a metaphysical entity as prime reason of at least the conceivable universe? Why should there be something instead of nothing? Is there sufficient reason to expect that the widely accepted verification of the existence of the elusive Higgs particle will provide an epistemic foundation to the incompatibility of observations between the macroscopic and the quantum level of reality? Further, is Bing Bang theory a complete one in the sense that it can consistently incorporate any newly acquired data (it is already doubted as ‘observationally’ sufficient), or is it just a theoretical model compatible up

2 Even in accepting the Higgs-particle's definite existence in accordance with the official announcement by CERN scientists on July 4, 2012 of the discovery of a Higgs-like particle, this fact will inevitably point to another regression of the chain of causalities within the real spatiotemporal world as it would be then raised the question of the prime underlying reason for the constitution of the Higgs particle and its associated Higgs field.
to a certain extent with the current empirical-epistemological paradigm? And given the advance of quantum theory one might also inquire into the bounds of human observational capacity regarding the microcosm and the way they are defined in the context of a quantum measurement.

Moreover one might ask whether quantum objects are ontologically self-standing, in the sense that they are spatio-temporally hypostasized entities or whether they should be taken as co-constituted each instant of time with reference to an observer's temporal consciousness which constitutes a quantum object or state-of-affairs by constituting itself.

All these questions have been discussed in the epistemological community for over a century as positive sciences in a striking advance that was strongly motivated by the industrial-technological revolution – a case of crisis of the epistemological paradigm in the sense of T. Kuhn – were led through theoretical questioning to new radical orientations. The radical shake up in the classical epistemological edifice, which had nevertheless given theories of such breadth as the Newtonian mechanics, the electromagnetic theory of R. Maxwell, the classical mathematical analysis and the variation calculus of Cauchy-Lagrange, etc., could not but provide a new content to the historically charged relation of positive science with philosophy and analytical logic. Given the general positivist tradition showcased e.g., by the positivism of A. Compte and from a certain viewpoint by the dialectical-materialism of Marx-Engels, there was a fertile ground for the development of new philosophical approaches that would face up to the new epistemological evolution to the extent that this latter set up a context of discussion that covered the ontological-categorial field of classical philosophy almost in its entirety. It is indicative of the convergence of the evolving philosophical attitude with current epistemology the view of a major representative of the Vienna Circle, namely of Moritz Schlick in his review of R. Carnap’s *The Logical Construction of the World (Der Logische Aufbau der Welt)*, in which he claimed that the fundamental concepts of philosophy are at the same time the most general concepts of sciences (Schlick, 2008: 200). As a matter of fact, the new epistemological domain included the subatomic realm, the birth and evolution of universe, the molecular structure of living organisms, etc., extending to the psychic automatisms and the constitution of the conscious self,
these being fields almost beyond the scope of positive science until the beginning of 20th century.

The Husserlian phenomenology and certain offshoots, e.g. the naturalistic version of M. Merleau-Ponty, as well as W.V. Quine’s holistic empiricism and R. Rorty’s neopragmatism among others, may be regarded as philosophical trends motivated by or interacting, to one or the other degree, with the aforesaid epistemological developments.

I take the occasion at this point to make, as somewhat relevant to the overall discussion, a brief reference to W. V. Quine's position which regards truth as dependent both on language construction and facts within-the-world. In Quine’s view, even analytical logic and mathematics are, in final count and through a certain system of interpositions, sciences of empirical descent referred, as all knowledge in general, to psycho-physiological processes based on an empirical and biological foundation ultimately reducible to the embodied human consciousness. A significant part of these interpositions is taken to be the structure of language itself as a mode of expression and communication, independently of whether we refer to the corpus of a formal language or to a loosely formed natural language, in taking into account that the structure of the human mind and the intersubjectively founded identity of constituted objects are themselves underdetermined by language.³

In the next, it will be shown that among the main 20th century philosophical trends phenomenological analysis predominantly transposes the level of discussion on certain open questions of positive science to a discussion of the constitution of objects of experience as well-meant objects within constituted temporality.

In the relatively recent and contemporary evolution of natural science one can say that there have been gradually formed two distinct cognitive contexts: the one of empirical physical science as a field of ‘observation’ and physical interaction equipped with an appropriate physicalistic language (e.g. in quantum theory in terms of the triangle, embodied consciousness-measuring

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³ On certain convergences of the Quinian theory of truth and knowledge as mediated by language and the Husserlian approach to the general notions of meaning and truth as ‘contents’ of intentional acts, see my article The Metaphysical Source of Logic by way of Phenomenology.
device-measured object), and that one of logical-mathematical science as a formal metatheory of empirical science and also as a formal-axiomatical theory in itself. This distinction seems to generate a two-fold inquiry summed up in the following: up to what level reach the ‘observational’ capabilities of an embodied consciousness endowed moreover, in M. Merleau-Ponty's view, with a reciprocal relation of a special architecture with the physical world, and at the same time, up to what point accede the expressional capabilities of a formal language by which are formalised on the level of theory the registered empirical observations-measurements? Is there a common underlying foundation to the limits of physical ‘observation’, on the one hand, and to the limits of formal language as a proper expressional tool, on the other? And if, indeed, there is such a common foundation, should it be found within a subject’s empirical field?

Truly, if such a foundation would be found within a subject’s objective spatiotemporal domain, it would then lead to a circularity to the extent that the observational-cognitive limits of reality would evidently be, in this assumption, at least co-determined by this same reality, implying therefore that they should form part of it. We could then be led to the paradoxical conclusion that the limits *de facto* imposed by our reciprocal relation with the universe of objective reality would be applied to transcend it. Consequently, the question of ‘existence’ of a pre-objective (or hyper-objective) ‘reality’ seems to be posed at this level, wherein in case such a transcendental type question could be regarded as well-posed one would then argue whether it can be a meaningful one in the absence of at least one phenomenological reduction-performing consciousness.

These given, I choose, in the next, quantum theory as the main empirical-epistemological field to refer to rather than the general theory of relativity.

The main reason is that the time parameter in quantum-mechanical processes is considered as external to the system and in a certain way as co-determining the objective existence of quantum objects/state-of-affairs, whereas time in macroscopic physical systems, irrespectively of whether they are taken as newtonian or relativistic ones, is considered as an internal parameter expressible through certain continuous mathematical
transformations (e.g. in the equations of motion or generally in the field equations of relativity).

It is a predominant conviction within the community of particle physicists that quantum ‘observation’ is associated with a subjectivity of some kind objectifying an entangled quantum state (effectively by objectifying time) in the transition toward the corresponding disentangled state. Further, this subjectivity is mediated on the classical level by means of a measuring apparatus and it is reflected in a formal-mathematical context by the non-isomorphic projection of the holistic non-Boolean field of entangled quantum correlations into the meta-contextual Boolean field that ‘disrupts’ the physical unity by introducing the self-evident presence of an intentionally oriented conscious subject within the physical world. As quantum theorist A.A. Grib has claimed, the jump of truth-values in the process of measurement, due on a formal level to the absence of an isomorphism between Boolean and non-Boolean structures (in accepting the latter as the formal means of describing the ‘inner’ entangled state of a quantum state-of-affairs), sets upon a Boolean ‘observer’ the constraint of existence of an objective, continuous time in terms of which he must ‘move’ (Grib, 1993: 2397).

Moreover, to the extent that the objectification of an entangled quantum state implies its constitution as a temporal object/state-of-affairs with regard to a temporal consciousness, by the same token it is annulled the possibility of a complete description of its inner temporality prior to its objectification by an intentionally oriented consciousness. Therefore, it is imposed a de facto limit in the complete knowledge of a quantum state in the absence of its ‘observation’. This de facto limit may provide some clues to the impossibility of a physicalistic description, that is, of a description in terms of the ‘language’ of the measuring apparatus of what takes place in-between the time of the performance of a quantum interaction through an experimental arrangement and the time of registration of this interaction. The impossibility of describing this part of the measurement process by the equations of quantum mechanics was clearly recognized by J. von Neumann and also prior to him by F. London and E. Bauer (Margenau et al., 1964: 7-8). It should not be left without due attention here that precisely von Neumann's Projection Postulate (or the ‘Reduction of the Wave Function’ postulate) points indirectly to the need for a self-constituting time flux by assigning to the mathematical translation $\tau((s)(t))$
of the physical state \( s(t) \) of a quantum quantity \( Q_i \) upon a first-kind measurement at time \( t \), the same eigenvector \( \psi_\kappa \) as with the translation of the state \( s(t_1) \) of the same quantity \( Q_i \) at time \( t_1 \) soon after the measurement.

Even if we assume von Neumann's Projection Postulate and Van Fraassen's modal interpretation of quantum mechanics as external metatheoretical conditions in a purely logical way, yet we cannot be led by any analytical linguistic means to a complete description of the ‘change of states’ that takes place during the measurement process in the compound system ‘system + apparatus’. In fact, the question of a possible subjective source underlying the metatheoretical description of a quantum measurement had been already brought up by F. London & E. Bauer in *The Theory of Observation in Quantum Mechanics* (La théorie de l'observation en mécanique quantique, London & Bauer, 1939). London and Bauer formalized the critical role played by the consciousness of an observer in the transition from an entangled case to a pure one by forging a global wave function \( \Psi(x,y,z) \) corresponding to the composed system [object(x) - apparatus(y) - observer(z)]. They claimed that it is not due to some kind of interaction between the apparatus and the object that produces a new \( \psi \) for the system during measurement but rather the consciousness of an ‘I’ (Ich) cutting the statistical correlations built-in in the global function \( \Psi(x,y,z) = \Sigma_\kappa \psi_\kappa u_\kappa(x)v_\kappa(y)w_\kappa(z) \) and setting up a new objectivity by attributing to the object a new function \( \psi'(x) = u'_\kappa(x) \). To the extent that this approach entails the constitutive non-reflective act of a temporal consciousness it raises the prospect of a more focused phenomenological approach with regard to a self-constituting temporal consciousness and the constitution of objects within it as noematic\(^4\) correlates of the moments of its outward directed intentionality.

S. French (2002), largely motivated by London’s & Bauer's assignment of a constituting role to the consciousness of a classical observer in quantum measurement, proposed a reading of the action of a ‘very special character’ of the ego in Husserlian terms. His approach seems close to the general position described above insofar as he refers to the domain of a potential observer in

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\(^4\) A noematic object manifests itself as a ‘giveness’ in the unity of the flux of a subject's consciousness and it is constituted by certain modes of being as such i.e., as an object immanent to the temporal flux with *a priori* categorial objectivities attached to it.
terms of a quantum mechanical description and applies the Husserlian notion of a characteristic act of reflection by means of which the phenomenological ego can reflect on its act of ‘observation’ and ultimately on itself. By this act of reflection the ego can separate itself from the superposition and set up a new objectivity thought not in terms of a bizarre collapse of the wave function but rather as a mutual separation of the Ego-pole and the object-pole, establishing this way a relation subject-object of an intentional character through this very act (French, 2002: 484-85). At this point one should be careful enough to properly understand the meaning attributed to the phenomenological pure ego as in Husserlian phenomenology it is commonly meant the ultimate subjective source of any conscious being-in-the-world. Which, by its non-objectifiable, a-temporal essence, should be absolutely extraneous to the world of phenomena. Yet, even though the absolute ego was left by Husserl as an obscure notion to the end of his life he was always preoccupied by the ontological vacuum that would be left as a residuum in admitting to an infinite regression reflecting-reflected in the temporal constitution of the world of objectivities. Therefore he thought of the ultimate subjectivity of consciousness (i.e., the absolute ego) as partially accessible both through its ever-in-act ‘outward activity’ in constituting the objectivity of phenomena and ultimately of itself, and also through the reverse activity of apodictically experiencing it in identification by iterative reflection in terms of the Ich-bin of phenomenological reduction (Husserl 2001b: 33-34 and 128-129).

From this standpoint the Ego-pole cannot but ‘be’ intentionally constantly engaged in a prima facie ‘empty look’ at any potential object, its act of objectification being taken in the quantum context as the attribution of a definite state to a quantum object among its distinct component-states predicted by the theory. My point, however, is that although S. French refers to the Ego-pole as something not ‘substantial’, in fact as an absolute subjectivity over and above its act of reflection (making reference for that matter mainly to Husserl's Logical Investigations and Ideas), he has not taken into proper consideration the temporality of the phenomenological ego in establishing new objectivities upon ‘observation’. For, in accepting the constituting role of the absolute flux of consciousness, we must concede that it ‘forces’ its homogenous temporality upon seizing the objects of phenomenological perception, including quantum objects/states-of-affairs as intentional individuals, and transposing them in its
homogenous immanent flux. But what about the origin of its own temporality, in other words, the temporality of its non-objectifiable ego? Any original act of reflection on itself will produce its objectified version and consequently will be constituted in the same objective continuous temporality as all other immanent temporal objects. In my view, this is a deep enough question which has ultimately to do with the origin of temporality itself and may be indirectly associated on an epistemic level with the time parameter in quantum mechanical processes, to the extent that it is taken as external to the quantum system and as a co-constituting factor in the decontextualization of a quantum measurement.

In this approach, quantization conditions stemming from appropriate boundary conditions and also the continuity of the time-evolution operator of quantum particle states are regarded as owing to the intrinsic property of quantum objects to be embeddable in a unified meta-contextual temporal frame of probabilistic description. This is meant as equivalent to ‘embedding’ reproducible quantum observations in a meta-contextual Boolean substructure associated with a homogenous internal time flux. This possibility involves at once, on a phenomenological level, a relationship subject-object of an intentional character and the noematic constitution of quantum objects as well-defined ones within the unity of consciousness. Independently of the context compatible with the preparation of a quantum experiment there should be some intrinsic way by which quantum objects taken as intentional objects become re-identifying immanent objects of a constituting consciousness invariably over homogenous temporal unity. Eliminating then all time-related modes of noematic constitution (e.g., simultaneity, succession, casual relationship) there should be an underlying temporal substratum of the predicative universe of quantum mechanics whose temporality should be something radically different from the ordinary objective time taken as an internal parameter of a classical macroscopic system. In this view the unifying, meta-contextual time of the predictive tool can be seen as ultimately reflecting the objectified unity of the absolute flux of temporal consciousness of an ‘observer’ which should be in an intersubjective sense the same objectified unity of any other potential one.

Yet, the origin of temporality of the pure phenomenological ego may provide ground for further research on a yet unexplored field and it is a problem that according to Husserl's own confession presented him with grave
difficulties to the end. I just note that later in the *Bernau Manuscripts* he described the absolute ego in terms of an unknown primordial process (*unbewusster Urprozess*) beyond temporality, whose reflection upon itself cannot but produce its own objectification (which is obviously not itself) within objective temporal unity (Husserl, 2001a: 203-207).

3. Toward a holistic approach of epistemic objects

The argumentation above virtually reduces the question of ontification within a quantum context to a question of the origin of temporality, or more precisely to a question of constitution of temporal objectivities which should in turn be associated with a constituting subjectivity. On this account, the epistemological question of quantum existence and identification can be reduced on the level of evidence to the phenomenological analysis of temporal consciousness and the search for a no further reducible subjectivity which cannot but always ‘be’ the time-constituting factor and never the time-constituted objectivity. This quest ultimately led, beyond the bounds of specific *a priori* intentional structures of the constituting flux of consciousness (e.g. the transversal and longitudinal intentionality), to a rather obscure absolute (a-temporal) ego of consciousness, meant as the absolute constituting factor of the objective unity of temporal consciousness.

My point is that this absolute subjectivity of temporal consciousness, inaccessible to any kind of objectification except through its own ontic ‘mirror’-reflexion, ultimately grounds as a common transcendental root both the constitution of quantum objects on the fundamental level of intentional experience and the constitution of certain mathematical objects in a sense to be further described. Concerning quantum objects/state-of-affairs the ultimate subjective factor may be seen to condition through the intentional-constituting forms of the absolute flux of consciousness their constitution as well-defined temporal objects, while its implicit presence in the constitution of objects of mathematical theories may be traceable in those objects whose formal existence
implies a notion of actual infinity\(^5\) (e.g., those of cardinality greater than countable cardinality \(\aleph_0\)) or those implying a notion of infinitesimality-in-actuality (e.g., the hyperreal numbers).

It should be noted that at a later stage Husserl considered objects of mathematical theories as a special class of perceptual objects which may be taken, in the sense of objects of pure logic as \textit{mathesis universalis}, as complete mental abstractions through a particular kind of intuition (categorial intuition) independently of any material content or form by which they might be instantiated. In the more phenomenologically founded orientation initiated with the publication of \textit{Logical Investigations}, as Husserl gradually rid himself of psychologistic preoccupations, he pointed to the \textit{a priori} character of intentional directedness toward last individuals-substrates of analytical logic, these latter objects thought of as ‘general somethings’ (or objects-anyhow, \textit{Etwas-überhaupt}), possibly ‘empty’ of any content taken together with devoid of content categorial objectivities such as relation, order, unity, plurality, etc. (Husserl, 1974: 81-82). It was in \textit{Formal and Transcendental Logic} (\textit{Formale und Transzendentale Logik}) that Husserl faced squarely the question of grounding mathematics in these terms as a formal-ontological discipline, namely a discipline in a fully comprehensive sense whose universal domain is delimited as the range of the highest form-concept, the object-anyhow; that is, the range of the object-anyhow thought of in the emptiest generality with all in this field a priori generated and hence conceivable derived forms which always give new forms in an ever iterable construction (Husserl, 1974: 82).

To this class of objects he included all those objects/states-of-affairs (\textit{Sachverhalte}) expressible by any syllogistic or arithmetical axiom (or theorem) and by every inferential form and also every number, every numerical formation, every function of pure analysis, and every well-defined Euclidean or non-Euclidean manifold (Husserl, 1976: 33-34).

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\(^5\) Actual infinity can be taken to be a kind of infinity freely generated in our consciousness in the sense of the unity of a whole in presentational immediacy. Consequently, it should not be identified with physical spatiotemporal infinity conditioned on the laws of causality. On the level of formal theory, it may be taken as representing any form of inexhaustible infinity apprehended as a completed whole in the actual now.
The whole approach meant a shift from the established view of logic as the exact pure science of idealized objectivities to its reassessment as fundamentally referring to the experience of being within the lifeworld, this latter notion meant in a most fundamental pre-predicative sense. In this view, a genealogy of logic understood as a transcendental clarification of its origins and primarily focused in elucidating its development as an apophantic discipline should inevitably consider predicative judgements as the essential foundation of logic. This, in turn, calls for a further reduction of predication on the level of unambiguous evidence, based on the fact that the world is the universal ground of all possible substrates of predicative judgements, of all that is, in intersubjective fashion, made knowable and logically posited. It is remarkable that the lifeworld as the universal horizon of all meaning-acts was considered by Husserl as related not only to the meaning attributed to the objects as objects of possible knowledge but also to everything the natural sciences (of his time) had rendered as determination of beings. Therefore, the meaning of any objectivity is so defined that all the attributes of being as rendered by the contemporary natural sciences belong to the world (in the sense of a universal horizon) within which it is specified (Husserl, 1972: 39). In the *Analyses of Passive Synthesis (Analysen zur Passiven Synthesis)*, and in a further elaborated notion of objects presupposing the act of rememorating, Husserl explicitly included in the class of objects the noetic and noematic structures of intuiting experience which have become scientific objects (Husserl, 1966a: 327).

In this perspective, mathematical objects as syntactical objects (with a proper semantical content) of a formal theory taken as general ‘objects-anyhow’ in the sense of individuals at the lowest level of intentional experience, may be considered as fundamentally temporal objects insofar as they are constituted as immanences within the homogenous flux of a subject’s temporal consciousness. It follows that the intentional structure of a self-constituting temporal flux is inherently tied to the character of definite mathematical objects

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6 The lifeworld in Husserlian phenomenology can be roughly described to a non-phenomenologist as the physical world (in a most fundamental sense) in its ever-receding horizon including in an intersubjective sense all phenomenological reduction-performing subjects in a special kind of presence in the world. More on this in E. Husserl’s *The Crisis of European Sciences and Transcendental Phenomenology*, (Husserl, 1962).
as well-meant temporal ones. It determines, for instance, the essential character of a convergent sequence of natural numbers as a complete mathematical object although it is a re-iterative, finitary process of a discrete character extensible ideally *ad infinitum*.

Husserl thought of formal-mathematical individuals as a special case of quasi-individuals in contrast to ‘real’ individuals of physical perception (corresponding to an absolute temporal position), even though he considered that in both cases the individual essence of corresponding objects encompasses both the identical temporal duration of each one and the identical distribution of temporal fullness over this duration. This individual essence tends toward unity in their perfect likeness (of ‘real’ and quasi-individuals) and, even more, one may assume that in the noematic stock of each lived experience there is always one individual essence (Husserl, 1972; English translation, App. I, p. 382). In contrast, the constitution of sets as collections of individuals and also of sets of a higher order (classes) as collections of sets, etc., is conditioned on the possibility of their constituting as completed totalities in the immanence of consciousness and in the actual now of reflection irrespectively of whether infinite sets are formally postulated as denumerable or non-denumerable ones. In the case of sets or of classes of sets one should distinguish between the act of colligation or drawing together of a sequence of objects and the act of constitution of these sets as thematic objects in actual presence. In this view a set as an original objectivity is preconstituted by an act of colligation which links disjunct objects to one another and is complemented by what Husserl called a retrospective apprehension (*rückgreifendes Erfassen*), an act whose content is that of the thematization by the constituting ego of a collectivity preconstituted through the polythetic act of colligation into an identifiable and re-identifiable object possibly posited as a substrate of judgments (Husserl, 1972; English translation: 246-247).

In this view, the invariant, transtemporal, and abstract character of mathematical objects can be interpreted in a phenomenological approach that is radically different from classical or naive Platonism. And even though mathematical objects are meant and grounded as invariants of phenomena, that is, as invariants of appearances referring to our experience, yet they are taken as objects that could subsequently (i.e., in a post-constitutional sense) be taken to exist even in the total absence of subjects. For instance, the atomic predicate
formula $X \in P$ or $X \notin P$ may be considered as transtemporal in the sense that it is an abstract syntactical form referring to an idealized content of a cognitive act that can be in principle realized any time by any subject in a way that it is always intersubjectively$^7$ the same. Richard Tieszen has worked out a conception of mathematical objects largely in this sense, namely as abstract and mind-independent. The terminology used pertains to his conception of the objects of mathematics and logic not as abstract and mind-independent in a purely platonic sense but, in the context of his proposed constituted Platonism, as invariants of a subjective constitution which are nonetheless subjected to rationalistic constraints imposed by our living experience in the life-world and the usual mathematical practice (Tieszen, 2011: 115 and 149).

Now, I draw attention to two intentional-constitutinal structures which are, in my view, critical in the interpretation of certain mathematical conjectures which involve a notion of actual infinity and also in the interpretation of the process of quantum objectification.

The first one relates to the modes of constitution of intentional objects, including both perceptual objects of the physical world and imaginary objects of our mental faculties, as temporal immanent objects within the constituting flux of temporal consciousness having as a result that their ontological being is reduced to their temporal re-identifications within the continuous unity of the flux. On this account, one can claim that the (circularly defined) continuous unity of the absolute flux of temporal consciousness and a tergo the transcendental character of its pure ego induce an impredicativity$^8$ of infinite mathematical objects meant as completed totalities in presentational immediacy within the homogenous inner temporality. For instance, such an infinite mathematical object can be considered an open interval of the real line.

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$^7$ The notion of intersubjectivity can be said that it grounds, among other factors, the identical, invariant and thus transtemporal character of an object, irrespectively of whether it is a physical or a formal one, on the possibility of its definition as the ‘common denominator’ of the corresponding intentional acts of potentially all knowing subjects.

$^8$ Generally, an impredicative notion is one that the definiens cannot but be defined in terms of the definiendum in the sense that the definition of an entity (object, concept, etc.) somehow involves or presupposes a totality that includes the entity being defined.
whose definition is regarded as impredicative as it cannot be described but in terms of its parts (i.e., in terms of basic open intervals) which are of the same genus as the whole. My view is that the essential being of all mathematical objects or concepts associated on a formal level with the notion of mathematical continuity is reducible to their subjective constitution as completed immanent totalities in presentational immediacy, which is a process further reducible to the continuous unity of a self-constituting temporal consciousness.

The second of the aforementioned intentional structures is not conditioned in its description on the notion of a constituted time, being rather an *a priori* directedness to lowest-level individuals of our pre-predicative experience. To make it clear, let us try to imagine something more fundamental in our intuition than lowest-level individuals, irrespectively of whether we talk about a quantum interaction and its registration by a classical-level apparatus or a deconstruction of a formal analytical sentence to its no further analytically reducible constituent elements. As a matter of fact, we cannot transcend this ‘lowest’ level of intuition meant as intuition of evidences originally presented to an intentional consciousness and apprehended as the non-reducible content of corresponding intentional acts possibly taken as close in meaning to the Aristotelian τὸδὲ πτ (this-something). These no further reducible intentional objects in the broader sense of general state-of-things (*Sachverhalte*) to the extent that they are thought of as devoid of any content that might be associated with a material or generally a thingness substance, were taken in complete abstraction by Husserl as belonging to the class of objects of universal logic and, in particular, to the domain of objects of formal mathematical structures (see, p. 9).

This ‘lowest-level’ intentionality which may ground what in mathematics is associated with the intuition of the concrete, finitistic and discrete can be thought to determine on the constitutional level along with certain intentional structures of the absolute flux of consciousness⁹ (i.e., the transversal and longitudinal intentionalities) the conception of completed

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⁹ The absolute flux of consciousness is described as the self-constituting temporal flux of consciousness which is the field of the subjective inner temporality and the modes of constitution of immanent objects within it. Even this absolute source of temporality has a subjective ego (i.e., the absolute ego) whose objectification may be taken the absolute flux of consciousness itself upon reflection, see Husserl, 1966, §§ 34-37.
mathematical objects as, for instance, the notion of a choice sequence of natural numbers as a completed formal object or the intuition of a recursive set, etc. It is inconceivable, though, in the absence of a temporal constitution inherently associated with the objectified, continuous unity of the flux of consciousness insofar as, for instance, any generation of an infinite sequence of finite sign-configurations (think, e.g., of members of an arithmetical sequence as purely formal individuals) can be taken as a completed mathematical object only thanks to the subjective continuous unity of temporal consciousness.

This given, I consider this position on an underlying phenomenology of the mathematical continuum as pointing, in a certain sense, to the interpretation given by R. Tieszen to certain incompleteness results of mathematics and, in particular, to Gödel's second incompleteness theorem (Tieszen, 2005: 133-134). I remind that Gödel's two incompleteness theorems which are of prime importance in mathematical foundations have raised far-reaching philosophical questions as to the sound foundations of mathematics and logic in claiming (the second incompleteness theorem) that no formal-mathematical system be as simple as the system of arithmetic can prove its logical consistency with its own internal proof-theoretic means. In other words, it is shown that the semantical content of a formal mathematical system transcends the expressional capacity of the corresponding formal linguistic means.

As a matter of fact, Tieszen took as the fundamental reason of the proof of the incompleteness of formal-axiomatical theories the non-eliminable by a finitary combination of symbols (taken as sign-configurations) ‘inner’ meaning of non-finitary mathematical concepts. Yet, he does not seem to make any reference to a possible reduction of the impredicative character of actual infinity, or at least of the non-rigorously finitistic character of metatheoretical objects implicitly generated in incompleteness proofs, to the constitutional-intentional structure of a temporal consciousness underlying the continuous unity of its immanent objects. It looks as though this kind of phenomenological reduction of the classically viewed transtemporal objects of mathematical theories to objects immanent to consciousness each time of reflecting on them is a yet largely unexplored field in the philosophy of mathematics.

Apart from foundational mathematics, one can also find insights into how phenomenological notions can serve as an alternative interpretation of
standard mathematical theories or even as the conceptual foundation of new nonstandard ones in the work of logicians and set-theorists who claim that the existence of infinitesimals and infinite cardinals has a subjective ‘observational' character. This ‘observational’ character is essentially linked with the modes of intentionality of an ‘observer’s' consciousness who views the standard ZFC (Zermelo-Fraenkel Set Theory & Axiom of Choice) set-theoretical framework in a ‘local’ and non-Cantorian way. In this sense, the Alternative Set Theory (AST) (Vopěnka, 1979) and the Internal Set Theory (IST) (Nelson, 1986) properly interpreted, along with certain ultrafinitistic ramifications, the Nonstandard Class Theory (NCT) and the Theory of Hyperfinite Sets (THS), are generally considered as the main pillars of an alternative nonstandard mathematical approach.

More specifically, by making reference to a local and non-Cantorian way of ‘observing’, it is primarily meant that the actual infinity conceptually incorporated in the Cantorian ZFC theory as a metatheoretical, impredicative notion is refuted and substituted, e.g. in AST theory, by a notion of natural infinity which gradually manifests itself in the observation of macro or micro-scale phenomena present in very large sets. For instance, such phenomena are related to the intuition of the topological continuum in ‘observing’ a concrete physical surface. More specifically, the main contributor of AST theory P. Vopěnka has described the notion of countability in these terms:

‘Our capacity for observation and distinction is limited by the horizon in all directions. Needless to say, this applies not only to optical observation; the horizon is understood in the sense of E. Husserl’s Krisis der europäischen Wissenschaften und die transzendentale Phänomenologie. If a large set X is observed, then the class of all elements of X that lie before the horizon need not be infinite but may converge toward the horizon. The phenomenon of infinity associated with the observation of such a class is called countability’ (Vopěnka, 1979: 39).

On the other hand, the intensional part of nonstandard analysis (mainly represented by E. Nelson’s Internal Set Theory) can be metatheoretically interpreted as based on the subjective ‘observations’ of a potential observer realized in a local and non-Cantorian way so that that infinitesimals and infinitely large numbers do not exist in an objective way as in the extensional
case (e.g. in A. Robinson's classical nonstandard analysis), but their existence has a subjective meaning and is related to the observational limitations of the interacting observer. In fact, the introduction of the undefined predicate *standard* along with three ad hoc axioms in the axiomatical machinery of Internal Set Theory is metatheoretically associated with a factor of vagueness in connection with a infinitely extensible series of ‘observations’ carried out in an essentially discrete mode (Nelson, 1986: 4-14). It is suggested, for instance, that: ‘finiteness’ + ‘vagueness’ = ‘unlimited’, where ‘unlimited’ is a non-Cantorian equivalent to (actual) infinity.

In any case, the phenomenological influence, even though somehow simplistically asserted, is more straightforward in the AST version insofar as, in Vopěnka’s own account, the notions of intersubjectivity as well as those of the locality and extensibility of the observational horizon are essentially meant in the broad sense of Husserl's lifeworld in the way it is described in *Krisis* (Husserl, 1962).

In view of the discussion thus far we can say that the Husserlian reduction of the principles of analytical logic in the construction of apophantic sentences (and ultimately of formal-mathematical propositions) to subjective primary evidences of experience which refer to objects as originally registered by experience and further temporally constituted as categorial ones, may lead to the following four important claims in connection with the scope of this article:

First, the reduction of the laws of analytical logic to subjective evidences of intentional experience may be, under proper interpretation, associated with the semantical content of nonstandard mathematics. The metatheoretical content of nonstandard theories stands, in effect, in the discarding of the platonistic nature of the existing ZFC system (which formally incorporates a notion of actual infinity) and its substitution by a witnessed universe correlated with the presence of a potential ‘observer’ in whose extensible horizon infinities and infinitesimalities, even though axiomatically defined, refer to his subjective observations.

Second, the intentional ‘observation’ to lowest-level substrates of apophantic and generally of analytical statements as irreducible evidences of individuals bearing no further analytic inner structure points to a hierarchy of infinitesimals of various orders. In it, the infinitesimals of a given order appear
to be points without structure to the immediately lower order until we unravel their own structure in a kind of a Russian doll game and reveal a class of infinitesimals of a still higher order playing provisionally the role of atoms-points. In nonstandard analysis this refers, for instance, to the definition of elements in the nonstandard extension $\mathbb{R}^*$ of the set of real numbers $\mathbb{R}$, which have an inner structure as equivalence classes of infinite sequences of standard real numbers, modulo an ultrafilter $\mathcal{F}$ over the set of natural numbers. In such a case, the standard real numbers in the classical sense are the irreducible individuals of $\mathbb{R}^*$.

Third, in phenomenological perspective, the aforementioned reduction of analytical statements gives the dialectical opposition between discreteness and continuity. Moreover, it motivates, on a fundamental level, a notion of actual infinity as the formal abstraction of an intuitive continuous unity, whose origin may be found within the immanence of temporal consciousness. This (impredicative) actual infinity is formalized in certain versions of nonstandard mathematics by means of *ad hoc* prolongation axioms in saturated enlargements of the domains of standard axiomatical systems.

Fourth, insofar as nonstandard extensions of the domains of classical mathematical systems – e.g., the uncountable extension of the domain of countability by the prolongation principle in AST theory (Vopěnka, 1979: 41) – presuppose the preservation of the categorial-relational properties of the individuals of the standard domain of the theory, we can associate the concept of these individuals to that of thing-like ‘points’ taken as ‘visual atoms’ in a process of fragmentation that ultimately leads to *minima visibilia*. It is notable that Husserl had pointed out the essential similarity of the visual field to itself on a large and small scale and went on to clarify that there is an immanent similarity which, as evident generic similarity, justifies the transposition of the eidetic relationships discovered, so to speak, in the macroscopic universe to the microscopic ‘atoms’ situated beyond divisibility (Husserl, 1973: 166).

4. The bounds of objective reality

As it is well-known, the role of a conscious, reduction-performing subject in the constitution of a co-determined ‘objective’ reality and the ontological context generated for that reason is of primary importance in phenomenological
analysis. This way the phenomenological approach determines the breadth of the field within which a conscious subject may pose well-meant ontological questions to expect well-founded answers.

Let us consider, for instance, the concept of the phenomenological horizon taken of course not in the common meaning of the physical horizon but in the sense of a field which is co-determined by the intentional consciousness of a subject in its self-evident presence in the world and also by nature itself as a pre-phenomenological domain. The bounds of this horizon are inalienable to the extent that they refer in a reciprocal fashion to the constitutional character and the intentional modes of a subject's consciousness. Yet, they are all the same transposable inasmuch as it is transposable a subject’s field of phenomenological perception (Wahrnehmung). In this view, current cosmological conjectures about a multiplicity of universes or even the notion of parallel universes are at least phenomenologically naive, as any hitherto ‘unobserved’ cosmic reality would stand for any being who is a biological carrier of a consciousness a priori provided with an intentional-constitutional structure simply a transposition of his ‘local’ phenomenological horizon.

The reference in one or other way to a consciously interacting biological subject and the special architecture of his relation with the surrounding physical world are significant factors in the predominant current interpretation of the four global (rather than universal) constants of physics, that is, of the gravitational constant $G$, the Planck constant $\hbar$, the velocity of light $c$ and the Boltzmann constant $\kappa$. In a very concrete sense, these constants represent the inherent limits of human knowledge which are, on the one hand, inescapable and inalienable and, on the other, transposable just as the phenomenological horizon mentioned above. It follows that the four constants of physics articulate the existence of those ‘horizon’ lines that separate us from the infinitely small and the infinitely great. Accordingly, we can loosely say that the relativity constants $G$ and $c$ are associated with the impossibility of the definition of an absolute space and time in the universe, whereas the constants $\hbar$ and $\kappa$ are associated with the bounds of the subatomic universe in discarding a well-meant and deterministic reality.

Equally important is the claim that the mode of constitution of an objective reality by a subject who is a bodily carrier of a self-constituting
temporal consciousness determines not only the ‘depth’ of observation within physical world but also the limits of the corresponding formal metatheory. In view of the argumentation of previous sections, this is a position that can be based on Husserl's view of objects of mathematical theories, mainly in *Ideas I* and in *Formal and Transcendental Logic*, as objects founded on a categorial intuition. This means: as objects associated with certain intentional acts whose content should not be necessarily identified with a material-spatiotemporal one, in such a way that these ‘vacuous’ objects are essentially thought of as general ‘somethings’ along with their specific empty of content categorial forms. Due to this reduction, lowest-level objects-individuals of analytical and consequently of formal-mathematical sentences lead to no further analytically reducible evidences of our intentional experience, evidences that cannot even have an ‘inner’ temporal form (Husserl, 1974: 181). Consequently, both mathematical and physical objects inasmuch as they are taken as immanent objects of consciousness and in abstraction as invariable, transtemporal objects of formal theories, can be viewed on the same terms as temporally constituted objects whose temporality is recursively founded in the following order:

1. The absolute flux of consciousness which constitutes temporality by constituting itself.

2. The multiplicities of appearances, or, in other words, the immanent objects as durations within the homogenous temporality of consciousness, this latter considered as the pre-empirical time and,

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10 Categorial intuition is the kind of eidetic intuition described in Husserlian writings as reaching a purely formal object, e.g. an object of formal logic, by abstracting from an intentional content and positing the object in question regardless of a material or ‘empty’ content in the sense of an ‘object-whatsoever’ with all its essentially belonging transformations and relations. This is an intuition not to be taken as solely a process of abstraction through which we can be led by modification over content to a common invariant part of a real object, even one that is left with no traits relative to a material content. See: Husserl, 1984: 661-665.
(3) The objects of experience in objective time, that is, the objects of experience of each subject and intersubjectively the same objects identically (in constitutive mode) for all (Husserl, 1966a: 73).

Further, to the extent that objects of a formal mathematical theory are categorial objects within a subject’s temporal consciousness, it may become by this virtue meaningful an alternative interpretation of the undecidability of fundamental mathematical assertions concerning any higher-order than countable infinity. On this account I point, concerning the incompleteness results mentioned in Section 3 (pp.XX), to the non-rationally defined finitistic character of metatheoretical objects entering as formal ones in Level-2 assertions (these are assertions essentially conditioned on a universal quantification over an indefinite ‘horizon’). As it is known, Level-2 formulas are critically involved in the proof of both Gödel’s incompleteness theorems and Tarski’s Undecinability of Truth Lemma.

If it is doubtful whether we can be sure about the validity of universal mathematical sentences especially when they express ontological claims relative to their variables as universals, it is all the more so concerning the validity of universal empirical sentences of physics in case we do not presuppose an ad hoc indefinite extension of the domain and ‘morphology’ of our constitutional experience which nevertheless we have no way to empirically prove. In set-theoretical mathematics, the negation, for instance, of a universal sentence within the set of real numbers (i.e. the Archimedean property) leads to the ‘exotic’ universe of nonstandard reals.

In short, there is no objective reality independent of the constitutional modes of a subjectivity referred to it; and if such a reality would indeed exist, it would not be possible to describe it but mediately and intersubjectively determined by the constituting consciousness of all biological subjects performers of (phenomenological) reduction, which means by all human beings. If science is taken, in principle, as intimately associated with the objectification of living experience, then experience eludes its scientific description in the ‘residuum’ of its constitution as an objectified-ontological structure within objective spatio-temporality and its subsequent abstraction by means of a formal theory. Consequently, scientific truth is conditioned on the objectification constraints posed by the constituting faculties of humans as conscious beings-in-the-world and the expressional capacity of corresponding
formal theories in the language by which they are mediated.\textsuperscript{11} It is remarkable, though, that in spite of the depth of the metatheoretical questions arising from this subjectively founded approach, mathematical models serving as theoretical idealizations of physics have proved over time particularly effective tools in the \textit{in rem} description of the world of experience.

5. Conclusion

If the great theoretical questions on the incompleteness of mathematical theories having at least the degree of complexity of the theory of arithmetic and also those pertaining to the undecidability of critical conjectures involving mathematical (actual) infinity\textsuperscript{12} have a common underlying root with the great open questions of contemporary subatomic physics-quantum mechanics, this might be the reduction of their context of reference to a subjective temporality constituting one. After all, the phenomenology of time was for Husserl part of an epistemological program seeking to validate natural sciences by means of a phenomenological science of the essential structures and the constitutive functions of pure consciousness. As mentioned earlier in the article, the subjective inner temporality may be further reducible to its absolute origin, the ego of temporal consciousness, paradoxically meant as a transcendental subjectivity within a surrounding concrete world susceptible of sense attribution.

The special ‘architecture’ of the reciprocal relation between a biological subject bearer of an intentional, time-constituting consciousness and the surrounding physical world and the concept of a transposable, yet inalienable, cosmic horizon. which is induced by this kind of ‘architecture’, determine the limits of scientific knowledge and the scope of well-posed questions in reference to the objective world. In this sense and taking account

\textsuperscript{11} The reader may consult W. V. Quine’s argumentation on the matter in \textit{Word and Object} (Quine, 1960).
\textsuperscript{12} On recent research concerning undecidable infinity statements, e.g. the Continuum Hypothesis or the existence of inaccessibly infinite cardinals, see W.H. Woodin’s work in (Woodin, 2001\textsubscript{a}), (Woodin, 2001\textsubscript{b}) & (Woodin, 2011).
of the discussion on the place of phenomenological analysis in the interpretation of the world of science, one might not accept those questions which are commonly qualified as metaphysical or teleological as well-posed. It seems that in such cases, one should remain silent in the Wittgensteinian sense of the word.

Yet, phenomenology can prove an incisive interpretational tool in the description of the world of phenomena, as broadly conceived in the context of the lifeworld meant as the soil of primitive experience, whose apprehension and elucidation would be rather established in terms of the *Sosein* of reality as referent to the evidence of a constituting consciousness rather than in terms of a platonic mind-independent *Sein* of this very reality.

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