THE NOTION OF LOGOS FROM HERACLITUS TO MODERN PHYSICS

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Abstract

In this paper I argue that we can solve the interpretation problem of quantum mechanics and the question of ontology of Quantum Field Theory on the basis of simple metaphysical position: The connection of the phase space with the ancient Theory of Logi[1] of Beings, which is, by giving ontological meaning to the entities which "live" at the phase space, the Hamiltonian or Lagrangian formalism. There is a physical subject of such functions and it is the logos of a being. Therefore we can refer to the logical space as the total sum of logi of being. The result of this position is that we can attribute to the wave function a physical meaning, a special case of logos of a being and also give an ontological meaning at a quantum field. The developed metaphysical scheme can interpret the quantum paradoxes, by using the commonly accepted mathematical formalism. It can also interpret certain issues of Quantum Field Theory, although further study of this topic is necessary.

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[1] Logi is the plural for the Greek word Logos

1. Introduction-The metaphysics in physics

The ontological question in modern physics found itself in the frontline of interest in the first half of the twentieth century and seems to be leaving it at the end of that century. Not because it stopped to be interesting, but because there is no way to deal with it. The question is what is the nature of the world in which we live, what is the structure of the universe. The non-informed will assume that this question has an (almost) obvious answer, but when we enter the world of very small or very large objects it remains essentially unanswered[2].

However the answer to the ontological question remains important for all those who have philosophical concerns, and also because the answer forms the central lines that scientific research follows. Ontology is nothing but metaphysics and modern science has been developed basically in conflict with the traditional, theological, metaphysics. This is probably the reason why modern scientists have approached the ontological problem of physics solely from the perspective of mathematics and physics and underestimate or even ignore traditional metaphysics. As a result, approaches based on the territory of traditional metaphysics are not very popular.

The result is to focus on the development of the mathematical formalism that is believed to describe the physical world, and build mathematical models that are increasingly complex and ever harder to control if they are truly related to the natural world. This path leads from one dead end to another. A typical example is string theory or quantum gravity, which attempt to answer the question of the fundamental structure of the universe, which have ultimately led to a swamp[3]. This current situation may justify the investigation of an alternative road, the one of traditional metaphysics.

In my doctoral thesis[4] I followed this underestimated way of thinking which led me to the Hypothesis of Logical Quanta (HLQ). The HLQ is a metaphysical proposal which aims to answer the interpretational problem of quantum mechanics, through the framework of the Theory of the Logi of Beings as it has been developed in ancient and medieval philosophical thought.

In this paper I examine the HLQ further, translating the ancient philosophical tradition to a simple metaphysical position which describes the structure of the natural world. The HLQ is a result of this position. In this process I use the standard physical and mathematical formalism, showing that, in fact, we do not need new mathematics but a new interpretation of physics and mathematics, a more developed physical ontology. Necessarily I deal with a large number of issues particularly complex and it is inherently impossible and probably not necessary to present them in detail. I describe these ideas mathematically, but not exhaustively because this exceeds the limits of a philosophical paper. The aim of this paper is not to develop a new formalism, but a new interpretation of, traditional, modern physics. As for citations, I often

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[2] JAMES T. CUSHING, *Philosophical concepts in physics, The Historical Relation between Philosophy and Scientific Theories*, Cambridge University Press, 1998, p. 45, Greek edition.

[3] As is set discreetly in the introduction article of, WEINSTEIN, STEVEN AND RICKLES, DEAN, "Quantum Gravity", *The Stanford Encyclopedia of Philosophy* (Spring 2011 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/spr2011/entries/quantum-gravity/, These theories are (still) under construction. A construction that lasts longer, nearly 100 years since grappled with this Einstein.

[4] GEORGE MESKOS, *The Hypothesis of the Logical Quanta*, Armos, Athens 2009, Greek Edition. A summary of this work in English can be found at http://philpapers.org/s/Meskos%20George

refer to the excellent book by Roger Penrose, *The Road to Reality*, Jonathan Cape London 2004, not only because there you find all you need for this work, but also because it is given in a way that makes it suitable for a philosophical paper such as this. I refer, also to some other books and papers and in the end, give a bibliography.

The final result is the creation of a powerful interpretative model of the structure and functioning of the world in which we live. Such a model can then be extended to very interesting anthropological hypotheses and broaden the research field of natural sciences in areas traditionally considered inaccessible to them.

2. The ontological problem of modern physics and the theory of the logi of beings

There are many ways to describe the ontological problem of modern physics, especially in quantum physics[5]. There are also many natural phenomena which reveal it, in other words, in which it appears. The problem can be summarized as following. The entities of the microcosm, i.e. photons, electrons, etc. while in the interval between two successive measurements of one of their properties, appear to have features that none of the entities known to us can have. E.g. they appear to "exist" throughout the entire space or time, they "communicate" with each other in a quite paradoxical way, etc. On the other hand, the entities of the macrocosm show none of these characteristics, despite the fact that they are certainly formed by the entities of the micro world.

The problem then is typically philosophical. What is the nature of the fundamental constituents of our world, what is ultimately the nature of the universe? These questions attract the interest of the human mind from the beginning of philosophy, but the one known as quantum paradoxes maximized this interest and also highlights the importance of the corresponding epistemological questions. The interest is directed primarily to entities and events that are not directly observable but are perceived from the results in various experimental devices or by certain natural phenomena which are felt directly by our senses. E.g. the question what is the nature of gravity, which is an immediately noticeable effect, but the cause that produces it cannot be seen.

While those involved with the philosophy of science recognize that all these modern questions were at first posed and studied by the Ionians natural philosophers, and were processed by the ancient philosophical thought, a fact that was recognized by the pioneers of modern physics[6], the latter do not believe that the answers provided by the ancient philosophers could be useful today. It is likely that this is due, to a certain degree, to the fact that they know neither the whole nor the depth of ancient philosophical thought[7].

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[5] See: DAVID ALBERT, *Quantum mechanics and Experience*, Harvard, 1994, JAMES T. CUSHING, *Philosophical concepts in physics, The Historical Relation between Philosophy and Scientific Theories,* MICHAEL DICKSON, *Quantum Chance and Non-Locality*, Cambridge University Press, 1998, WERNER HEISENBERG, *Physic and Philosophy*, Penguin Classic[3], Great Britain 2000, PARTHA GHOSE, *Testing Quantum Mechanics on New Ground*, Cambridge University Press, 1999.

[6] WERNER HEISENBERG, Physic and Philosophy, and ERWIN Schrödinger, *Nature and the Greeks*, Cambridge University Press, 1954.

[7] Such a typical case is the one of the French physician ROLAND OMNÈS who suggests that while the logos could be a response to the problem of interpretation of quantum physics, however, he knows logos only through the work of Plato, essentially ignoring use of logos by Heraclitus and the

So the ancient philosophical tradition, along with others, developed a description of the entities that constitute the entirety of human experience, which today we call theory of the logi of beings[8]. This ontology has been of particular interest, but has a huge communicational handicap. It was developed as part of the theological controversies of the Middle Ages, or rather was the canvas upon which the theological controversies of the Middle Ages were based. The main corpus was developed in pre-Christian era, but the full expression was acquired in the mid-medieval times. As a result, it was known mainly in theological circles and remained essentially unknown to non-theological ones. And right here lays the importance of my doctoral thesis in which I recorded the full development of the concept of logos as the ontological foundation of the natural world. I began from the texts of pre-Socratic philosophers, especially Heraclitus, and reached to the writings of Maximus the Confessor. This presentation also highlighted the possibilities that are opened up by the philosophy of the theory of the logi of being to set up an interpretative scheme able to respond to the needs of the philosophy of science.

So, according to this model, we could say that the beings are complex; their entirety is made from their logos and from what man experiences in his senses[9]. The being is determined in all its physical characteristics and its relations with other beings, by its logos. Or conversely, the logos is an entity over which the being is somehow "sitting" on. Logos and being are inextricably entangled to each other and the actions of the first affect the other. However there is a very interesting difference. The beings "live" in time and space, but the logi "live" outside of time and space. Also a logos may be "pure" logos, that is not being expressed in space and time, that is, a logos who has not "entered" in space and time[10]. A very important feature of the theory of the logi of beings is that the logi have a linear tree structure; although each compound logos is a composition of different logi, it may have additional properties that the individual components do not have[11].

These features of the theory of the logi of beings make this scheme suitable for the development of ontology of the natural world as a model to explain all natural phenomena which pose unanswered questions to the traditional ontology of physics.

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tradition based on him. ROLAND OMNÈS, *Interpretation of Quantum Mechanics*, Princeton University Press, 1994, p. 527.

[8] HANS URS VON BALTASAR, *Cosmic Liturgy, the Universe According to Maximus the Confessor*, Communio Ignatius, convertible by German, BRIAN E. DALEY, S.J. 2003 SERGE MOURAVIEV, The Hidden Patterns of the Logos, *The Philosophy of Logos*, Volume 1 Athens 1996, LARS THUNBERG, *Microcosm and Mediator*, Open Court, Chicago 1995.

[9] The most clear and comprehensive text on the subject in which Maximus wants to describe the complexity of the natural world and the difficulty of the human mind to acquire full knowledge of it: "What are the logi that were implanted deep into the existence of each of the beings under the first principle according to which each is by nature and took form and shape and composition, strength and energy and ability to suffer, not to mention the differences and specifications in size and quality, relation, place, time, position and movement and habit ... "J. P. MIGNE, Patrologia Graeca, vol 91, 1228

[10] In ancient and medieval philosophical tradition the logi "live" in the mind of God and in this sense are out of space and time and some "time" the materialized in space and time. This feature utilized by Christian theologians to resolve sophisticate theological problems about the creation of the world by God from absolute nothing. Detailed analysis in, GEORGE MESKOS, *The Hypothesis of the Logical quanta*, pp. 105

[11] J. P. MIGNE, *Patrologia Graeca*, vol 90, 447

3. Logic space, or logi of beings and the space of phases

I begin by presenting my interpretation of my model by looking at a simple physical entity, a normal physical body. According to the theory of logi, the relationship of logos to the entity is continuous. The logos specifies the individuality of being, i.e. its characteristics, namely the mass, charge, spin, etc., also determines the motion, i.e. its evolution in space and time and its relations with other entities-bodies.

- We can represent this relationship of logi to entities as a "space" in which the logi "live" as the "base" upon which "is established", i.e. ontologically founded the world of phenomena we observe. This "space" I call "logical space" and the world of phenomena I call the physical world. Each "point" or possibly "area" of the logical space is continually associated with a corresponding entity in the physical world.

In modern physics there is a similar form but reverse. Specifically, to consider a physical system, i.e. to describe and predict its evolution in space and time, we use the so-called space of the phases, which has other names, such as space of places or configuration space. This space is an abstract mathematical space that has as many dimensions as the independent variables or degrees of freedom that determine the system status[12]. Each point corresponds to a complete description of the system status at a certain instant of time. The full description includes all elements and all the characteristics of these elements of the system.

What is important and interesting in this description is that in the space of phases "exist" entities that may have a known structure which describe the evolution of the system completely. These "entities" are mathematical functions with relatively simpler form than the functions describing the system directly, but not only. The system can be completely incomprehensible in direct contact, but the function that describes it in the space of phases may be quite simple, or even have very specific properties. The space of phases is usually a vector space of many or infinite dimensions and often has specific characteristics - symmetries- that define it and help us draw very important theoretical and practical conclusions, even when we may not have a comprehensive approach in it.

The functions in the phase space have the form:

$$F = F(x_1, x_2 \ldots x_n; \dot{x}_1, \dot{x}_2 \ldots \dot{x}_n)$$

Where $\dot{x}_i = \dfrac{dx_i}{dt}$

And describe orbits and generally geometric shapes in the abstract mathematical space phases, completely independent and different from the physical space in which the entities they describe "live". The history of the system is represented by a curve in the phase space. The phase space has neither independent spatial nor independent temporal dimensions because time and space are some of the internal characteristics of our system. In this description the various properties and their derivatives of time are independent variables[13]. From a point of view inside the system, time flow and space stretch. In the phase space there

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[12] TERENCE TAO, PHASE SPACE, Department of Mathematics, UCLA, Los Angeles CA
www.math.ucla.edu/ ~ tao / preprints / phase_space.pdf
[13] ROGER PENROSE, *The Road to Reality*, Jonathan Cape London 2004, p. 507.

is no time or space, as independent variables, however, each point describes the evolution of the system in space and time.

The phase space is an information space; it provides us with information on the evolution of the system, i.e. information about the life of the being. This observation combined with all the previous ones leads us naturally to the correlation of the phase space and the space of logi of beings, the logical space. In fact, if one considers the theory of the logi of beings, he will be led to a slight change in wording.

- A mathematical entity in the space of phases does not describe a being but she prescribes it, therefore she has ontological content, has a kind of physical nature, and is a special type of physical entity.

In other words, the phase space is no longer just an abstract mathematical space but is, or rather reflects a physical reality which is the ontological foundation of what we regard as the natural world. A physical reality that exists simultaneously with the physical world we perceive with our senses[14].

The system and the phase space are inseparable; a being is formed by the space of phases and its implementation-expression on the physical world. The space phase is another side-aspect of the physical world, and mathematically can have infinite number of dimensions and is equivalent to the logical place to which I referred earlier.

- So a being is extended both in the logical space and the physical world, and the fundamental reality is not in the physical world but in logical space. What we perceive as physical reality is consequential, totally different to that which our common intuition informs us of.

The logical space is not exhausted at the phases of space. The phase of spaces is a mathematical construction that is limited by the capabilities of mathematics that have been developed so far. The logical space as a physical reality is broader than every description that can be built by man, same as happens generally about the physical universe. Here are posed all the epistemological questions raised by the philosophy of science. What is important is to note that the space of phases we revealed as such because there exists the logical space, because the universe is built on the logical space.

In this sense, we can assume that mathematical entities that exist in the phase space correspond to the logi, but there must be more logi which we cannot describe with a function. To understand the structure and properties of the logical space we can use the knowledge to be gained from the study of the logi, who we can study mathematically. When we construct a model for the natural world we should make a generalization of the conclusions to be drawn from this study. Under these circumstances, the generalization will be neither arbitrary nor unreasonable.

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[14] A similar approach, with very different starting point, is developed in the article *The principle of relative locality*, by GIOVANNI AMELINO-CAMELIA, LAURENT FREIDEL, JERZY KOWALSKI-GLIKMAN, LEE SMOLIN arXiv: 1101.0931v2 [hep-th] 31 Jan 2011

4. The formation of the logical space

The aim is to develop a model that can represent the entirety of physical reality, i.e. both the physical reality and the logical space. For this purpose we use the mathematical tools available to us. Here is posed strongly the question of the relationship of our model with physical reality. This question, found in all scientific fields, has no definitive answer. I will make some assumptions on which I will follow.

- The first is that the physical world actually exists and is as we perceive with our senses.
- The second is that we cannot understand the fullness of the natural world only with our senses, so we expand our knowledge by logical thinking, philosophical thinking.
- The third is that we still do not exhaust the physical reality. There is always something we miss.

The human senses have direct access to the four dimensions of space-time. The existence of the logical space compels us to add extra dimensions, the ones of the logical space. For the mathematical description of such cases, has been developed a mathematical theory of fiber bundles which is appropriate to describe what we are looking for. The fiber bundles are used to describe physical realities and the corresponding physical models with more than four dimensions, something that is very common in modern physics[15].

A bundle of fiber $\mathcal{B}$ is a mathematical structure[16] that connects mathematical entities. It connects two different mathematical spaces with a particular way. It assigns each point in a space with a multitude of points of another one. In a fiber bundle $\mathcal{B}$ we consider a vector space, or rather a manifold $\mathcal{M}$ which is the basis of a total space. On every point p of manifold[17] $\mathcal{M}$, so to speak, is grounded another manifold $\mathcal{N}$ in which "live" parts of the total space, which we consider to be the natural world. The $\mathcal{N}$ is called fiber, due to the fact that the first such manifolds studied were simple lines. In a series of points of $\mathcal{M}$ sits a set of fibers, i.e. a bundle of fibers $\mathcal{N}$, hence the name fiber bundle $\mathcal{B}$. The $\mathcal{N}$ in its general form can be a manifold of many, or infinite dimensions.

All these dimensions are somehow internal dimensions of the point p of $\mathcal{M}$. Usually $\mathcal{M}$ is the space-time, and in this sense to each point of space-time may correspond, or better exist, another "world" living in the manifold $\mathcal{N}$. So the point p is given a somewhat inner life that does not "appear" in $\mathcal{M}$. This life is expressed by a rule called normal projection, linking, i.e projecting the points of $\mathcal{N}$ in one of the points of $\mathcal{M}$, and in the end, the points of the total space of $\mathcal{B}$ in $\mathcal{M}$.

Both the $\mathcal{M}$ and $\mathcal{N}$ can have particularly internal features[18], and that is what makes the whole idea functional and useful. The fiber bundle is the mathematical structure used to connect a physical system with its space of phases[19]. In the $\mathcal{N}$ and more accurately in the cotangent

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[15] JOHAN DUPONT, *Fiber Bundles and Gauge Theory*, Rhus Universitet, January 2003

[16] ROGER PENROSE, *The Road to Reality*, p. 325.

[17] JOHN ZOIS, *Introduction to differentiable manifolds*, http://www.free-ebooks.gr/gre/ebook/624, Greek Edition.

[18] That is, symmetries, symmetry groups and gauge connections

[19] TERENCE TAO, PHASE SPACE, Department of Mathematics, UCLA, Los Angeles CA www.math.ucla.edu/ ~ tao / preprints / phase_space.pdf

space at each point of $\mathcal{N}$ is a function $\mathcal{H}$ called the Hamiltonian[20] in honor of the British Mathematician Hamilton, who first studied these functions, for which we know about and which we will refer in detail below.

In our interpretation all of this is completely reversed. Space-time is no longer the base area, but it is the logical space $\mathcal{L}$ on which the fibers of space-time $\mathcal{M}$ are sit. The projection is not from $\mathcal{M}$ to $\mathcal{L}$, but conversely, from $\mathcal{L}$ to $\mathcal{M}$.

- The projection from $\mathcal{L}$ to $\mathcal{M}$ is continuous and is a constant relationship between $\mathcal{L}$ and $\mathcal{M}$ and is our fundamental metaphysical hypothesis, which draws its inspiration from the ancient theory of the logi of beings. The space of the phases as an ontological entity is continuously connected to the realities which "live" in the physical space.

Let us now describe how our model works. In ontological terms is first and foremost the logical space in which logi "live". The logi can be considered as compounds of instructions and information. The logi have the capacity to express themselves in physical space and thus to maintain the existence of beings, those which we observe in the natural world. All this physical reality is described mathematically by a set of fiber bundle, in which $\mathcal{L}$ can be considered as a base and to every point λ of $\mathcal{L}$ corresponds a fiber $\mathcal{M}$. The set of $\mathcal{M}$ expresses and describes the physical world. The point λ moves in a way that we will describe later. The curve on which λ are moving corresponds at the physical space to the points of intersection of $\mathcal{L}$ to $\mathcal{M}$ through a process of elevation of the base on the total space, a process that is reversing the normal projection[21].

- The movement of λ in logical space, the elevation of $\mathcal{L}$ in physical space or the inverse relationship of the normal projection of $\mathcal{M}$ in $\mathcal{L}$ constitute what in ancient times is called logos of being.

The interpretative model we present here is an inversion of the usual representation; however it is not a simple reversal of the base space, but a metaphysical-ontological extension. Indeed, in our model we do not have a physical space and an abstract mathematical space but two real spaces directly and inextricably linked that are equally natural. The phase-logical space represented by $\mathcal{L}$ is as real and natural as the space-time that is represented by $\mathcal{M}$, which corresponds to the physical space. And points p and λ represent physical entities, although to each λ correspond a multitude number of points p.

- The world of our experience may therefore be regarded as described by a bundle of fibers in the logical space, where each fiber includes a space-time history of only a part of the being, since the whole being consists in its fullness both of the reality of space-time but also the reality of logos of being. A being is always represented by

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[20] It should be noted that very often we use another function, the Lagrangian L, which is defined in the tangent space at each point of the phase space. In this article we will refer exclusively to the Hamiltonian for convenience because there is a simple relationship between the Lagragian and Hamiltonian:

$$H = \dot{q}_\iota \frac{\partial L}{\partial \dot{q}_\iota} - L$$

and as about on philosophical point of view the two functions are identical.

[21] ROGER PENROSE, *The Road to Reality*, p. 331.

both points p and λ. The basis of p is always a λ. We are entities of type p, we perceive the λ only indirectly.

Exactly how all this works and what the consequences are, may become apparent by studying simple cases first in classical systems and then the fundamental constituents of the universe, by focusing on that area of quantum mechanics.

5. The Hamiltonian describing

In classical mechanics the time evolution of a physical system running a Newtonian-inertial motion is described by the Hamiltonian $\mathcal{H}$. For a simple Newtonian system consisting of a finite number of bodies, let's say i, at any time the system is described by the coordinates p_i of the position of bodies, which may include the orientation angles and the coordinates of momentum q_i of each body. The representation of all these properties is the space of phase and the specific setting of each body corresponds to a point on it.

The Hamiltonian $\mathcal{H}$ then

$$H = H(p_1, p_2, \dots p_i, q_1, q_2, \dots q_\iota)$$
  1

is the function that has as arguments the coordinates position p_i and the coordinates of momentum q_i.

And we have these very generalized relations:

$$\frac{dp_i}{dt} = -\frac{\partial H}{\partial q_i} \text{ and } \frac{dq_i}{dt} = \frac{\partial H}{\partial p_i}$$
  2

The $\mathcal{H}$ in systems with energy conservation, and in real physical systems we can always assume that the energy or momentum is maintained, is independent of time and is a vector flow in space phases, namely the traffic in the space phases, a move that describes the spatiotemporal evolution of the system[22]. Knowing the $\mathcal{H}$ with the help of appropriate relations we can calculate the position and momentum, i.e. the velocities of the bodies of our system. In other words, there exists a mathematical entity at the space phases that fully describes our system.

Coming back to our interpretation, we search the structure of the logical space $\mathcal{L}$ and a description for the logos of being, namely the points λ. The Hamiltonian gives the logical space specific mathematical properties.

- If we start from the simple system mentioned earlier, it is obvious that while at first $\mathcal{H}$ is independent of both space and time, on the other hand it describes the spatial and temporal evolution of the being, and thus satisfies the basic requirements to be suitable for representing the logos that is connected with the point λ of the system, and vice versa a logos can be expressed by the $\mathcal{H}$, from a physical point of view[23].
- In this case we can write:
  o $H = H(\lambda)$
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[22] ROGER PENROSE, *The Road to Reality*, p. 475.
[23] It should be noted that the representative or expressive association of points λ with H does not mean they match or they are equal.

This function is certainly appreciable only for simple systems, but qualitatively one can assume that a similar relationship exists for all physical systems, even though it is far beyond human computational capabilities.

It should be noted that there cannot be equivalence in a generalized way of the logos of a being with $\mathcal{H}$, because the logos may contain information about the being which are not described by $\mathcal{H}$. For a simple and almost idealized system, as the one we are talking about, one can assume that the logos coincides with $\mathcal{H}$. This identification gives us, as already noticed, a fundamental knowledge about the structure of the logical space. This is because, although it is not always possible to calculate $\mathcal{H}$, it gives specific features to a logical phase-space which are particularly useful for the study of natural phenomena and the formulation of physical theories[24], a fact that significantly strengthens our hypothesis that indeed $\mathcal{H}$ has ontological status.

Although the existence itself of functions as the Hamiltonian reveals some characteristics of logi, the study of the corresponding functions on the fundamental level of the world, the one of the microcosm, gives us all those details about the structure of the logical space that are necessary for the formation of an integrated model about the structure and the function of the natural world.

6. The wave function ψ

Although in quantum mechanics is applied nothing from classical Newtonian mechanics, however, $\mathcal{H}$ plays a crucial role in the formulation of quantum theory and quantum field theory[25] and leads us directly to the Hypothesis of Logical Quanta. As will be seen, HLQ is the corollary of the ontological inversion that I talked about earlier, changing the word "describe" with the word "prescribed" in the definition of the phase space.

Returning to the world of quanta we process the so-called quantization. In this, although the mathematical formalism changes in some critical-points, $\mathcal{H}$ plays again a crucial role. Indeed, in quantum mechanics the space of phases is in the front line but the $\mathcal{H}$ is no longer a function of independent variables but a function of abstract mathematical operators. Instead of the momentum p_i there are the operators:

$$p_i = i\,\hbar\,\frac{\partial}{\partial x_i} \qquad\qquad 4$$

Instead of computing values we have an abstract set of operations! Momentum, a property that in our world always has a certain price, is equal to an abstract change in position. We therefore do not have numbers but "a possibility". Here it is already revealed that $\mathcal{H}$ is not something clearly defined, but is a description of a change. This is the beginning of paradoxes.

Change in the position, but of what? An operator is always applied to a function. In this case the function is the ψ, known as the wave function

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[24]Indeed studying the symmetries which are allowed by Hamiltonian can draw important conclusions about our system. ROGER PENROSE *The Road to Reality*, p. 489 and more detailed, SUNNY Y. AUYANG, *How Is Quantum Field Theory Possible?* Oxford University Press, 1995, p. 32

[25]ROGER PENROSE, *The Road to Reality*, p. 483.

$$\psi = \psi(\chi_1, \dots \chi_i; t) \tag{5}$$

Here x_i are the spatial coordinates of our quantum system and describe the quantum state of the entity, that is, the evolution in time and we say that it describes the quantum state of our entity[26]. We call it wave function, because in usual cases of simple particles it has some kind of a wave form[27]. The ψ is calculated from $\mathcal{H}$ according to the Schrödinger equation;

$$i\,\hbar\frac{\partial \psi}{\partial t} = H\psi \tag{6}$$

where of course

$$H = H(\,i\,\hbar\frac{\partial}{\partial x_1}, \dots i\,\hbar\frac{\partial}{\partial x_i}; x_1, \dots x_i) \tag{7}$$

We know that $\mathcal{H}$ represents the logos of the particle when under 6 and ψ depends on $\mathcal{H}$ and thus is also connected with the logos of the particle.

- But the quantum Hamiltonian is not like the usual Hamiltonian. We have seen that $\mathcal{H}$ is the quantum description of a property which has no certain value. In this sense the quantum $\mathcal{H}$ represents a logos different than a usual logos, a logos which does not correspond to a specific entity but rather to a potential entity, a logos that is not articulated yet with something specific in physical space.
- From 6 we deduce that the same should apply to ψ

It describes how ψ changes over time, i.e. the changing of the description of the quantum state of the system. It doesn't give us the specific values of the properties of a particle at a certain moment of time.

- Although it is a fact that the Schrödinger equation is describing ψ, it does not locate the particle in time and space.

Therefore ψ "live" only in the phase space, and according to our descriptive model, in logical space $\mathcal{L}$, and it does not describe the evolution of a physical entity, but gives us the evolution of the description of the entity and therefore, according to what we said previously, solely the evolution of the logos of a physical entity. We can write,

$$\psi = \psi(\lambda) \tag{8}$$

- Consequently, ψ has as its ontological subject a logos, and so we finally arrive at the core of HLQ, that a quantum entity or accurately an entity in a quantum state is only a logical entity, is one logos that is not expressed in the physical world.

The Schrödinger equation is a completely distinctive equation. Its right part is found only in the logical space $\mathcal{L}$ and describes the logos, while the left describes a rate of change in time, thus projecting to $\mathcal{M}$. However, the presence of i, the base of complex numbers, shows that this projection does not lead us to the real $\mathcal{M}$. According to what we said earlier the left side describes the rate of change, not an entity but the change of the description of the entity. To

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[26] This is determined by the nature of particles and which describe their relationships between each other, and the relation with the environment, the forces and the influences that carry this on them.
[27] ROGER PENROSE, *The Road to Reality*, p. 505.

get to the entity we need something more. And this is an act of measurement, an act of expression of logos in physical space, an act of entering of logos in the physical space and an act of lifting the curve $\psi\,(\lambda)$ from the logical space $\mathscr{L}$ to the total space of the fiber bundles $\mathscr{M}$, i.e. the total physical space, which we discussed earlier.

In reality it is acknowledged that the following happens: A quantum entity is "living" as such only between two successive measurements. At the time of measuring the quantum entity "loses" its quantum reality and becomes a common entity[28]. This is one of the mysteries of quantum physics that the HLQ enables us to say that the quantum entity between the two measurements is a "pure" logos, a logos that is not expressed in space-time, that is not associated with any physical entity. The process of measurement is a process that forces the logos in some way to be expressed in space-time.

7. The reduction of the wave function

According to our description the act of measurement is represented by a process of lifting the curve of ψ from $\mathscr{L}$ to the total space. For this we need a new correlation and such a correlation exists and is known from the quantum formalism. For any natural feature or property there is a suitable operator which, when applied on the ψ, has as a result a multiplying of ψ by a scalar quantity. This quantity, that number, is one of the possible values that a certain property which characterizes the physical substance of our entity could take.

Such an operator really exists in the quantum Hamiltonian. So, depending on the $\mathscr{H}$ and *the ψ* that is calculated by it, this operator has a series of eingenfunctions with the following property, namely

$$p_i\psi = P_i\psi \qquad\qquad\qquad\qquad 9$$

Where Pi is the numerical values that can take the physical property, i.e. the position or momentum or energy or anything else, the entity under study, and

$$p_\iota = i\,\hbar\frac{\partial}{\partial x_i} \qquad\qquad\qquad\qquad 10$$

i.e. the derivative in the position, or momentum, energy, etc. The index *i* can be finite or infinite. The procedure described is known as wave function collapse and happens in each act of quantum measurement[29]. Often called quantum jump, it is one of the most interesting quantum mysteries because here enters a randomness deeply hidden in the foundations of the natural world. Indeed after each measurement it is sure that we will find in our measuring system a Pi, but we never know what the value will be.

This mystery is explained through the interpretation of HLQ. Indeed when we make a measure, the logos of our measured entity is expressed in the natural world.

- The logos, however, as a non-spatiotemporal entity, can arise at any point in time and space as there is no reason or limitation to prefer a certain point, i.e. to get the measured property of a specific value. In any λ match all pi, and ψ is the one that incorporates information on how often every *pi* occurs, therefore determines the known possibilities of occurrence of a value of a physical property.

[28] ROGER PENROSE, *The Road to Reality*, p. 527.

[29] DAVID ALBERT, *Quantum Mechanics and Experience*, Harvard University Press, 1992, p. 80.

This reveals the interpretative power of the main metaphysical position we did so far, to give ontological content in the space of phases.

- Physically, each pi remains permanently connected to the corresponding λ by ψ (λ), which implies that it reacts directly without spatial and temporal constraints on any change of ψ which will be a result from any change in our experimental device or for any other reason. The famous quantum wave particle duality, quantum superposition and all paradoxes are the result of the fact that every being is constantly and directly connected to its logos. Any impact on the logos from the logi of other entities, i.e. an experimental device, is transferred directly into our entity.

Indeed the action of each test or measuring device can be represented as one operator Q acting on ψ. The Q can be differentiated at will, but the result is the change in ψ on $\mathcal{L}$ and an automatic projection on the total area and a corresponding automatic change of pi. So in the eyes of an observer it appears as though all pi exist simultaneously. It seems that there exist simultaneously particles with different values of Pi. They actually exist simultaneously but rather not as entities of our world, but as logi in logical space, which can be expressed as physical entities anywhere in physical space and time. This is the reason due to which a quantum entity, between two measurements, behaves as if it extends across space and time, but without infinite mass or energy. So when a measurement happens then the logos has to express itself in the physical space in accordance with the standards that ψ sets.

What is, however, the action of Q? To answer this question we must understand the nature of ψ. How then can we understand the reality of the wave substance of ψ, i.e. wave substance of a logos of a quantum entity? The wave function ψ can be written in the format:

$$\psi = e^{-iP_i {x_i}/{\hbar}}$$
11

and therefore ψ takes values on the unitary circle of a complex plane. We can therefore say that $\mathcal{L}$, which represents the logical space, is in general a form a complex space and as far as quantum entities are a plane of complex space. We can therefore say that the wave nature of ψ is due to the fact that at the $\mathcal{L}$, ψ moves on a circle in the complex plane which represents the $\mathcal{L}$, and since every point in the cycle with normal projection follows a spiral path that has wave characteristics, not in terms of energy, density or mass, but on the phase[30].

The logos, therefore, of a quantum entity is represented in $\mathcal{L}$ with a circle on the complex plane. In general form the $\mathcal{L}$ is a complex manifold on which we can represent the logi of beings, or at least part of the logi of beings, those that are representable. The logos of an entity cannot be changed. The location and characteristics of the entity in space-time may change, but the logos does not. Therefore the logos should be represented in complex manifold with a point[31]. In the special case of the quantum entity, the logos is represented by ψ which from (10) seems to be on the unitary circle on a complex plane.

The action of Q on ψ involves the "disappearance" of the cycle and the transformation of the representation of the entity's logos from a circle to a point which corresponds to a physical entity expressed in space-time. The logi, however, are not immutable, can interact with logi of other entities and then both the logic and the physical part of the being can be changed. The

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[30] ROGER PENROSE, *The Road to Reality*, p. 507.

[31] May be represented by a complex sphere. This detail is, like many other, issues to be explored.

circularity of ψ on ∡ explicates the linearity of ψ. The most complex logi should also be circular and when expressed in the physical world should be represented by a point. Now we understand how the connection of the theory of the logi of beings with modern physics, reveals the inner qualities of logi. The consequences are particularly interesting, but will be presented at a following paper.

In traditional quantum mechanics a main question is why the large physical entities do not exhibit quantum characteristics, while the small do. This question is crucial because the linearity of ψ remains essentially unanswered because a quantum entity is considered to be of the same nature as the non-quantum and therefore it is believed that the procedure described by 6 and the procedure described by 9 are two different processes operating on the same entity. The HLQ resolves this issue because it suggests that 6 refers to a certain part of the entity while 9 coexists with 6 and the two together refer to the fullness of entity. In the complete being there are always both of these processes. The Schrödinger equation is describing a quantum entity, but this entity is not a complete physical entity.

According therefore to HLQ, when a pure logos interacts with a logos of an entity whose logos is already expressed in the physical world, gets drifted alongside this already expressed logos, and is, as a result, also forced to be expressed in the physical world and "collapsing" the wave function. The cause of the emergence of the entity in the physical world is the establishment of ψ in a "logical" point of an existing physical entity. What makes an entity non quantum, but classical, is not the size but its functionality in the physical world and the connection with other entities.

In other words, the collapse of the wave function is caused by the logos of the measuring device which, acting on the logos of the quantum entity, forces it to be expressed in the physical world, from which it comes out again when the under examination particle re-enters a quantum state. The logos is entering and leaving the physical world, the particle emerges in the "existence" and is "lost" again in the eternal game of the microcosm. Paradoxically but not unreasonable, all these are verified by observation and experiment.

8. The HLQ and Relativity

I have already talked about space-time without mentioning the main problem of quantum mechanics that is the compatibility with relativity. It is known that the Schrödinger equation is non-relativistic; time is clearly a different dimension from spatial dimensions. From the point of view of HLQ, this is expected since the equation is for entities that do not belong in space-time. Of course there is a change of ψ[32] with respect to time, but the presence of the base of complex numbers shows us that this is not the usual time and that to move to the usual time we need something else, as explained in the previous paragraph. The HLQ shows that the incompatibility of relativity with quantum theory is neither a mistake nor a failure of theories, but arises from the fact that a particle in quantum state is a "pure" logos, an entity located outside space-time. The quantum theory and relativity do not refer to the same entities, but each to something ontologically different. This explains why so far every theory that tries to unify relativity with quantum theory has failed and nothing indicates a future success.

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[32] But in a complex plane. The complex numbers play a dominant role in quantum physics.

The question now is what happens when a quantum entity, i.e. a logos, enters the space-time. According to what we said the quantum entity collapses into an elementary particle. So what happens to it, what about this? These questions are what the Quantum Field Theory (QFT) seeks to answer. Here arises a large number of problems both interpretational and about physics. For this reason there is not just one QFT and more generally the question is opened to theoretical and experimental research. However, the HLQ, introducing the concept of logos, simplifies significantly at least the conceptual framework of QFT, while on the other hand the experimental data which support the QFT significantly strengthens the position of HLQ.

First we should refer to space-time. There is a fundamental question of whether space-time is absolute, i.e. if there are entities that exist in it autonomously. The answer was given first by Galileo and is negative. From this point began the debate on the nature and structure of space-time which led to Einstein's general relativity. Today it is assumed that space-time is dependent from the entities that exist in it, which is consistent with the ontological priority in HLQ of logical space to space-time.

Upon this we must consider the question of information transmission. If beings communicate with their logi then it can be assumed that information is transferred by logi, so we have a violation of the principle of relativity and causality. But that is ruled out by the way we describe the notion of logos. Logos is a prescription; it determines how the data flow in the physical world. The logos is information about data, but not data. Data, and therefore the information based on them, only exist in physical space. Thus the existence of logical space does not entail the violation of causality, at least as man is able to understand and use it in physics. All these are obviously in quantum entanglement, where although the quantum, i.e. when non-spatiotemporal, entities are correlated with each other, but this relationship cannot transfer information to the concept of broadcasting and transfer of data flow.

So data is exchanged only between entities and not between logi and therefore such information is transferred only in the space-time and so relativity is correct about the structure of space-time and the speed of light. There is an enormous philosophical significance of these at least for human beings. Existence can be understood only within the space-time. Maybe the foundation of existence is in the logical place, but a pure logos is only a possibility, a description of an option, not an entity. On the other hand a human being is immersed in both areas and it seems that we can experience both of them. This fact opens up very interesting interpretative horizons.

9. The HLQ and Quantum Field Theory

Returning now to QFT we should focus at the concept of the field. First we should see the classical fields, that of gravity and electromagnetism. The first thing we notice is that these fields are always caused by some body. The gravity is due from a mass of a body and the electromagnetic field from a body movement, if and when it carries an electric charge. The result is an influence of the area around the body, which acquires certain properties that can be felt if there've been around another body or charge. In other words, a mass or a charge extends their action well beyond their physical (geometric) limits.

Here, before issues relating to quantum mechanics appear, is posed the metaphysical question of what is a field, what is the nature of a field and how is it possible to act from a distance. It was already well known that a field carries energy and information and that the

electromagnetic field has wave nature. This wave nature reminds us the well known waves observed at sea and other fluids, so at first we sought a medium that, like incompressible fluid, should carry the energy of the wave. With the prevalence of the theory of relativity, the idea of the medium (ether) was abandoned and the ontological question for the carrier of the field remains essentially unanswered.

So the question what exactly is the nature of the field, and here we talk first about the electromagnetic field, initially ignored, and studied the field per se by Faraday and Maxwell. Finally they were made a series of equations describing the effect of a moving electric charge in his surrounding area.

The classic forms of Maxwell's equations are:

$$dF = 0 \,, \quad d^*F = 4\pi^*J \qquad\qquad\qquad 12$$

Where F is the tensor field of Maxwell and J is the vector of charge of current. In other words, we have a series of mathematical operations that do not involve any physical size. In one respect the situation resembles the equation of Schrödinger, the equations describe a change. But quickly appeared an quantity which is especially important from a philosophical point of view. This is the electromagnetic potential A and results from the first of equations

$$F = 2\mathrm{d}A \qquad\qquad\qquad 13$$

The A is an "elegant" entity that by itself has no physical significance. It describes the structure, the pattern of the field as it extends in space and time. But this formulation itself has no physical meaning or significance. It seems it does not exist until the moment that another entity appears and "carries" with it another potential A' and then what matters is only the difference of two potentials. Then A expresses the action of the field on the entity. We would say the A surrounds any entity that produces the field and it is reacting with the entities entering to it. In other words, entities entering a field understand because of the action of potentials, but potentials are not physical quantities, they cannot be measured regardless of any measurement or any other instrument[33].

- All these lead us to link the potential with the concept of logos of the entity, to attribute its existence to the action of logos, i.e. the logos of the entity acting on logos of the second entity makes it behave as if there is a field.

This is not arbitrary and blends with everything we know about potential and fields. This will become more understandable if we look at how Quantum Field Theory handles the fields and entities associated with the fields.

In the so far description of the classical field we handle an entity e.g. a moving charged particle and the resulting field as two entities of different nature. But when we move to the quantum level, the dualistic nature of quantum entities, namely that an entity can have both a nature of particle and wave paved the way for a holistic approach of particles and fields as facets of a single quantum field. Indeed in Quantum Field Theory there are only quantum fields and particles are only excitations of these fields[34]. These fields are of two types, one is material nature and the other is field of interactions of one of the four fundamental forces of

[33]ROGER PENROSE, *The Road to Reality*, p. 449.

[34] ROGER PENROSE, *The Road to Reality*, p. 610, How Is Quantum Field Theory Possible? p. 158.

nature, gravitational, electromagnetic, the weak nuclear and strong nuclear[35]. At any time these two fields are coupled and "produce" a physical entity. There is no one apart from another, i.e. there is no mass and charge in without of their respective fields.

This peculiar situation, QFT, described with the help of fiber bundles[36]. Now the base area is the space-time $\mathcal{M}$, where the particles move with the masses and charges. At each point of space-time there are two fiber bundles, one which is primary and which develops the interactive field $\mathcal{P}$ and one which develops the field of mass $\mathcal{D}$. According to QFT any entity in space-time extends over two ontological levels, one of an interactive field and a second of a material field.

At every point of a fiber the field has a particular configuration, a connection-gauge[37] which depends on the potential A, which we talked about earlier. So when two such fields come together and interact, then the two potentials determine the type of interaction, whose result is the communication between the two fields through the exchange of appropriate particles. While a potential has no meaning, because the connection has a mathematical but not a physical sense, the relationship between these potentials describes the reality of the particle which is exchanged between the two fields of the entities that interact.

This whole situation reminds us strongly of the correlation of phase space with physical reality, which is the foundation of our interpretative schema. Indeed the description of QFT relates the physical reality with geometry, with manifolds and connections on them[38]. The point is that the experiments confirm all these descriptions, the most prominent of which is the experiment where we observe the Aharonov-Bohm[39] phenomenon. We can therefore say that the concept of the fields $\mathcal{P}$ and $\mathcal{D}$ as components of the same entity have common characteristics, with the logos of the entity, or precisely the logos of the entity is in ontological terms, the carrier of the vector fields $\mathcal{P}$ and $\mathcal{D}$ that support the existence of the body that we observe. Therefore the sum of fields $\mathcal{P}$ and $\mathcal{D}$ constitutes the logical space $\mathcal{L}$.

In the field $\mathcal{D}$ "lives" the wave function ψ and the field is the "medium" through which the entity interacts with other fields. In other words, the logos may be considered to be divided into two components, one of which supports the existence of the body in space-time and the other defines the body's interactions with other bodies, through the logical space, i.e. interacting with the logi of other beings. So we have a full coverage at ontological level of QFT from HLQ, and vice versa as claimed once before.

- What actually adds HLQ to the current ontology of QFT is the fact that quantum fields still exist and play a key role even in non-quantum entities: The space phase corresponds always to a physical existence.

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[35] SUNNY Y. AUYANG, *How Is Quantum Field Theory Possible?* p. 219.

[36] SUNNY Y. AUYANG, *How is Quantum Field Theory Possible?* p. 133.

[37] ROGER PENROSE, *The Road to Reality*, p. 449.

[38] HERBERT J. BERNSTEIN and ANTHONY V. PHILLIPS, Fiber Bundles and Quantum Theory, *Scientific American* / July, 1981, http://www.stealthskater.com/Documents/UNITEL_14.doc

[39] ROGER PENROSE, *The Road to Reality*, p. 449, Fiber Bundles and Quantum Theory, *Scientific American*

If one remains at the traditional philosophical framework of modern physics, the ontology of QFT is uncertain[40]. The HLQ fills this gap and thus the most successful part of the QED acquires ontological foundation and the problem of virtual particles is resolved as there is the logical space in which fields $\mathcal{P}$ interact without actually appearing as particles in physical space.

Meanwhile, the starting point of QFT, a series of experimental observations on electrons and positrons, demonstrates the validity of the second proposal on the metaphysical keystone of HLQ which I have already said without a specific comment.

- Namely the fact that one logos can exist without been expressed in space-time, and could in some way either enter in it or leave it.

Indeed in a vacuum, in various experimental setups, appear and also disappear particles of matter and antimatter emerging in space-time from literally nowhere. This is unexplained ontologically but is still described in QFT with operators of creation and destruction that act on mathematical entities[41]. It is interesting that the creation and destruction operators are acting on a vacuum state and the result is the creation of material particles which are then destroyed and so the total sum of the energy remains constant. In other words, it is suggested that behind the vacuum there is an ontological reality from which emerge and to which dive, existentially, the various particles.

- This process is perhaps the strongest verification for the existence of the logical space of logi of beings and the Hypothesis of Logical Quanta.

In fact it is the expression of logi in space-time and their withdrawal from it confirming the answer to quantum paradoxes which gives the HLQ that suggests that a particle between two measurements just "depart" from space, or more correctly returns to the logical space.

In conclusion, the QFT creates numerous philosophical questions and here HLQ may be the philosophical foundation for their response.

While it is obviously necessary for a more detailed study of the topic, it can briefly be said that under the HLQ the concept of the field is replaced by the concept of logos.

- The space of the phases, i.e. the logical space $\mathcal{L}$ is the ontological foundation of the physical world.
- In this there are logi that have two actions. First sustain beings in existence and secondly establish relationships between entities.
- The $\mathcal{L}$ consists of that we recognize in quantum physics as quantum fields $\mathcal{P}$ and $\mathcal{D}$.
- It is possible the fields-logi do not to appear in the physical world. Their appearance in the physical world can happen either randomly, as quantum fluctuations of vacuum, or under the influence of a measuring device, i.e. a collapse of the wave function.

Usually in relativity we say that the gravitational field gives geometrical characteristics in space and so we have proper motion of bodies in it.

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[40] Quantum Field Theory, 5. Philosophical Issues, *Stanford Encyclopedia of Philosophy*, http://plato.stanford.edu/entries/quantum-field-theory/ # Philss

[41] ROGER PENROSE, *The Road to Reality,* p. 657.

- According to our interpretation scheme, we argue that the logi are forcing the body to move in order to look in our eyes, that space has geometrical characteristics. The same applies to other fields. In this sense, the field does not extend in space, but "lives" in a logical space and influences the shaping of the natural world.
- The logical phase carries the characteristics of the fields: Beyond the linearity of the composition of logi, it has a structure expressed by the various symmetries that characterize the fields.
- Information, same as complete beings, can only exist in the physical world. There may however be some kind of information that can be transmitted through the logical space.

This is something that might look like exceeding the speed of light in some experiments or other events. I believe we do not have the final knowledge on this subject.

- The spatio-temporal existence and the quantum state of an entity are of different ontological kind and cannot be reduced to something in common.

The cosmological implications of HLQ are already obvious and should be make it more detailed by connecting more accurate HLQ with the questions that concern QFT.

10.   Conclusions

The theory of the logi of beings, as a philosophical tradition of antiquity, leads us to a fundamental metaphysical position, to give ontological content in the phase space of classical and quantum mechanics. This metaphysical position then logically leads to the Hypothesis of Logical Quanta, namely to the identification of a logos of an entity, that is not expressed as a being, asa particle in quantum state. The HLQ also offers an ontological frame for quantum field theory, and explains quantum paradoxes. The observation of creation and destruction of elementary particles in vacuum is a strong confirmation of the full range of considerations of this work. With the tools it provides us with, the HLQ opens new ways for resolving first cosmological and then anthropological questions.

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