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IN SEARCH OF THE THEORETICAL AND CONCEPTUAL FOUNDATIONS OF THE MIND-PROBLEM: WHAT DOES PHYSICS HAVE TO SAY ABOUT THE BASIC CONSTITUTION OF THE WORLD?[1]

Leonardo Ferreira Almada (UFU)[2]
umamenteconsciente@gmail.com

Abstract: This paper is the first of a sequence designed to achieve a theoretical project I aim at developing along two interconnected parts, although independent of each other. This first part outlines the foundations on which I have supported my general treatment to the multiple problems raised by the interaction and integration relations between consciousness, mind, encephalon, body and environment. Therein I seek to outline what is known about the physical constitution of the world in the light of the best available theories of physics from the Standard Model of particle physics. Throughout the paper I attempt to show that, despite its limitations and shortcomings, the Standard Model is sufficient for my original purposes, although the gravitational force can only be incorporated through revisions and extensions of this model. The development of the arguments of this paper makes room for my next step, namely, to maintain that the basic theses of emergentism (physical monism, synchronic determination and systemic and emergent properties) offer the best material available for the research on consciousness and its place within natural world beyond the shortcomings of reductive physicalisms.

Keywords: Problem of consciousness-mind-encephalon-body-environment relations; Standard Model of particle physics; Physical constitution of the world; Physical monism.

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[2] Professor Adjunto IV do Instituto de Filosofia e do Programa de Pós Graduação em Filosofia da Universidade Federal de Uberlândia, Uberlândia, MG, Brasil.

1. INTRODUCTION

This present paper is driven by my interest to develop a sequence of interrelated and interdependent studies, all intended for the achievement of a theoretical project I propose to develop over two deeply interconnected parts. The first part of this project focuses on the foundations of the theoretical position I will try to consolidate in the second part. Its purpose is to demarcate and to clarify the structural, methodological, theoretical and conceptual foundations on which I establish the tools I need for supporting a general treatment to the multiple problems raised by the interaction and integration relations between consciousness, mind, whole brain or encephalon[3] (cerebrum,

[3] Note to the Brazilian readers: About the use of the terms 'brain' and 'encephalon', I agree with the translator (Laura Teixeira Motta) of the Brazilian version of the book published in 1999 by Antonio Damasio, entitled '*The feeling of what happens: body and emotion in the making of consciousness*', whose translated version was released in 2000 in Brazil under the title *O Mistério da Consciência: do corpo e das emoções ao conhecimento de si*. According to the translator (DAMASIO 2000, p. 41): "In English, the word 'brain' has two meanings: the first is the 'brain' itself, which corresponds to the usual sense of the word (*cérebro*) in Portuguese, designating the cerebral hemispheres and the deep structures of the hemispheres, including the basal ganglia, thalamus and hypothalamus; the second meaning — targeted here by the author — is equivalent to the use of the term 'encephalon' (*encéfalo*) in Portuguese, and includes not only the 'brain' itself, as explained above, but also the other structures that make up the central nervous system: the 'brain stem' — best saying, 'encephalic' — and the 'cerebellum'. In the translation of this book (*O Mistério da Consciência*: *do corpo e das emoções ao conhecimento de si*) we used uniformly the word brain (*cérebro*) — and its correlates — with the two meanings, both because of the difficulty to discern the meaning of the single term of the original and because of the current use of the word brain in the neurology, which often refers to the two senses of the term". The same understanding appears in numerous papers available on the internet. In Brazil, the notion of 'brain' (*cérebro*) as one of the parts of the 'encephalon' (*encéfalo*) also is supported by the classic and consecrated neuroanatomy guidebooks written by Angelo Machado (2006) and Roberto Lent (2010). In an interview to a Brazilian popular science website, Claudio Santos (2011) — a Brazilian neuroscientist who also supports this view — states: "It is worth starting off by establishing the difference between two terms: 'encephalon' (*encéfalo*) and 'brain' (*cérebro*). Between us (Brazilians), although improper, 'brain' is the most common and the most used term in everyday language. This is probably due to a translation problem happened long ago. The word 'brain' (*cérebro*), which in English refers to the 'encephalon' (*encéfalo*) was translated as 'brain' (*cérebro*) in Portuguese and so it remains today. In fact, human cognition depends on the 'encephalon' (*encéfalo*), that is, everything we have inside the head. The 'central nervous system' is divided into 'encephalon' (*encéfalo*) and 'spinal cord'. One of the parts of the 'encephalon' is the Cont.

cerebellum and brainstem), body, and environment. In its turn, the second step of this project — whose achievement depends on the full development of the first — has been planned to support my answers to the set of hypotheses that I have formulated with respect to the role played by the interaction and integration relationship between encephalon, body and environment in the constitution of the (conscious) mind.

In general, the first part of this rising project is divided into a textual sequence previously designed to outline the elements which ensure the unity, consistency and cohesion necessary to the set of positions that has guided my answers to the following problems: (i) What are the nature and the ontological status of the (conscious) mind?; (ii) What is the place occupied by the (conscious) mind within the natural world?; (iii) How does the (conscious) mind appear/arise from or emerges (as I want to argue) in organisms with nervous systems of sufficient complexity to instantiate the conscious life?; (iv) What is required for the appearance/onset or emergence of the (conscious) mind?; (v) Can mind and consciousness be treated as synonymous expressions?; (vi) Does the body play a significant role in the structuring and/or in the constitution of the (conscious) mind?; (vii) What is the role of the environment in the interaction and integration relationships between body-brain and the (conscious) mind?; and, among many other possible issues, (viii) Do the current discussions in philosophy of

'brain'. Why is it important to make this reservation? Because there are several cognitive aspects depending on the 'cerebellum' or the 'brainstem' and these two areas are not part of the 'brain' (*cérebro*). The neuroimaging techniques have allowed to verify that structures such as the 'cerebellum' (in the past related to motor function and balance) are very important for the excellence of the bodily movement, and more than that essential for writing, playing sports and all other types of bodily movements.

mind require structural and/or paradigmatic amendments to overcome the structural, methodological, theoretical, and conceptual limitations and weaknesses that have typified the philosophical treatment of the classic problem of mind-body relationships?

The first part of my project was structured and motivated by my conviction that a safe and well-established ground is crucial to ensure the consistency, cohesion and the sense of unity needed to consistently address the problem of mind-body relation considering the inextricable interaction between consciousness, mind, encephalon, body and environment. Such a conviction is also what explains why this series of works of the first part of the aforesaid project is in the service of my attempt to delineate the basic components and the general orientation of the position to be subsequently supported. Through this path — which can be metaphorically expressed by 'debris removal', 'preparing the ground', and 'establishment of foundations and structures' tasks — I aspire to 'erect a building' as immune as possible from the fundamental weaknesses and from the explanatory gaps that present themselves in the various and known contemporary 'sciences' of the mind, including the studies that have been conducted by philosophers, psychologists, psychiatrists, cognitive scientists, neurobiologists and neuroscientists in general.

In the current stage of the project, I would like to present what is known about the physical composition of the world in the light of the best — although incomplete — available theories of physics. The lack of a well-defined delineation of the basic physical components of the world and hence of the organisms' composition is perhaps what explains the multiplicity of perspectives — often incompatible

with each other — concerning the nature and the ontological status of the (conscious) mind, and the place of the mind in the natural world.

The purpose to scrutinizing the basic components of the natural world requires that I carry out a comprehensive list of the set of elementary particles of the world, as well as their laws, forms of interactions and charges, as well as the forces and fundamental fields of nature. My intention, therefore, is to come back to the original vocation of philosophy and hence to the task that typified the entrepreneurship of those we have considered the forerunners of Western philosophy, namely, the pre-Socratic philosophers: in common with them, my intention is to search for the Arche and for the most fundamental elements of the physis. This theoretical goal is still relevant for scientists who rely on dialogue with physics, especially in philosophy, psychology and neuroscience fields; it is true, on the other hand, that there is no current metaphilosophical consensus on the philosophical legitimacy of this assignment. Despite any agreement on this issue, this paper is a starting point for the development of my major undertaking.

2. METHODOLOGY

Although papers in philosophy rarely spell out the methodology on which they are based, I have chosen to present the path by which I developed this research to account for the difficulties raised by the highly unusual feature of my research in Brazil: I do not confine myself to authors — especially those who are included in the 'list' of genuine philosophers.

I seek to be as close as possible to the methodological

procedure that in methodology is often called 'systematic review of literature'. Given, however, that this methodological procedure is only a reference target, I will allow myself to seek the benefits of systematic reviews without restricting myself to its methodological constraints, although they are very effective for the researchers who pursue rigorous and legitimate methods and paths. On the one hand, the methodological rigor and scientific legitimacy of systematic reviews is what enables a consistent structural cohesion between (a) the guiding question of this work and (b) the necessary mechanisms to achieve (c) the goals motivated by the question. On the other hand, extremely rigorous methodological procedures can minimize the argumentative flow expected from philosophical works. Based on this diagnosis, I would like to go beyond the systematic review without sacrificing a clear definition of the steps and tools needed to maximize the effectiveness of the path I have chosen. In accordance with the systematic review of literature, this work is divided into five steps: (1) definition of the question; (2) search for evidence; (3) review and selection of the studies; (4) analysis of the methodological quality of the studies; and (5) presentation of the results.

(1) The present paper is motivated by the following question: what do the best available theories in physics teach us about the constitution of the world?

(2) To address the above issue, I have selected texts (especially papers and books) of the field of knowledge devoted to support theoretical models in physics. I will not make a complete detailing of my papers selection process for space limitations and respect for the reader. However, it might be appropriate to emphasize: after mapping the best current physical theories devoted to the world elementary

particles, the demarcation of the fundamental interactions and charges thereof, as well as to the forces and fundamental fields of nature, I have first picked up doctoral theses of these areas written since 2014. The theses were selected because (I believe) they provide the most reliable sources to acknowledge the current state of the art and are endowed with a high number of references. The temporal character of this selection is justified by my intention to find references that have followed the last confirmation of the Standard Model of particle physics. From these references, I have taken into consideration papers, current textbooks, texts of renowned researchers available on the Web (although not published in journals) and texts of the most respected institutions dedicated to promoting these areas of knowledge. I have also selected texts prior to 2014, if they are considered enlightening and informative;

(3) With respect to the review and selection of studies, I spent a couple of months confronting data and references to verify the amount of citations related to selected texts, as well as to investigate the impact factor of the selected papers, in addition to the legitimacy of publishers, websites and institutions in case of institutional papers or texts available in informal format. Given that I have no training in physics, I have adopted as exclusion criteria papers less basic and with bold proposals. An important inclusion criteria has been the sobriety of the proposal, the commitment to basic discussions of physical and the legitimacy of the references or the researcher institution, despite the ever-imminent and dangerous risk of appeal to authority (*argumentum ad verecundiam*). Much of the references were collected as the problems presented themselves;

(4) The doctoral thesis defended at the consecrated

universities were primarily chosen based on my belief that they follow the best methodological principles available. References presented in these theses were chosen for the same reasons, including articles, books and institutional texts;

(5) I will present my results from the next section on.

3. Is there a role for physics in the elucidation of the place of the mind in the natural world?

As highlighted in my introduction, my intention is to outline the basic components of the natural world in the light of the best physical theories available, so that later I will have the needed tools to investigate the place of the (conscious) mind in the natural world. Such a task requires an effort and an ambition that certainly seem presumptuous for any of the more contemporary eminent physicists. Indeed, the theoretical and methodological care we expect from scientists justify the fear and suspicion that they probably nourished by those who (like me) seek to draw up a comprehensive list not only of the elementary particles of the world, but also of their fundamental interactions as well as their charges and, moreover, of the forces and fundamental fields of nature. Many are the physicists who routinely deal with critical gaps by the best and the most prominent theories and that consequently admit their frustrations on the many still unsolvable issues, especially those without expectations of resolution. Therefore, it is natural that I grant to my readers the right of perplexity. I will grant them the following issue: how can I aspire a goal whose achievement is not expected even by the most eminent living physicists?

I now offer an immediate and optimistic response, although cautious: the success in describing the physical constitution of the world to think about consciousness and its place in the natural world does not depends on a final and definitive elaboration of a 'theory of everything' (or 'theory of all things'), a theory which can fully explain nature from its most microphysical level to its most macrophysical level. Indeed, the current state of art has been relatively satisfactory for those who intend to scrutinize the 'physical basis' of conscious mental life. After all, contributions from physics and from sciences thereon they most closely depend have been crucial for the explanatory success we have achieved in relation to: (i) the understanding of the nature and the ontological status of the mind in the light of the interactive, self-organizing and complex dynamics of organisms; (ii) the technologies we have developed not only to the knowledge of the central and peripheral nervous system — from which the most diverse brain scientists were benefited —, but also for practical applications regarding the neurological and mental health, promoting best practices in neurosurgery as well as more successful diagnosis and treatment by psychiatry and by neuroscientifically oriented research on human mind.

It would not be prudent to claim that the various brain and mind sciences as well as the biomedical areas dedicated to neurological and mental health have reached their full-fledged stage or have become sciences with full explanatory power regarding the mode of appearance/onset or emergence of conscious mind from the working of the nervous systems of the living organisms. Many gaps remain to be filled, and many facts need to be known. Even so, and regarding the problem of the mind-body relationship, we can

say we have reached a satisfactory level and now have some explanatory success compared to the level at which the philosophical and scientific conceptions of the mind were before the development of neurosciences and natural sciences. This comparison, however, should be at the service of a strategic intellectual modesty. Through a scientifically informed imaginative experience, we can place ourselves in a not too distant past to project that our current ideas will be refuted and/or falsified in the future, as evidenced by the numerous examples in the history of science (LAUDAN 1981).

Moreover, we have no reason to believe that experimental brain sciences offer incontestable reductive explanations for the qualitative aspects of consciousness. Maybe in the future our current conceptions have the same degree that we ascribe today to the Platonic, Augustinian or Cartesian doctrine of soul and mind-body relationships: at this moment, we do not have even the possibility to predict if someday we will achieve a thorough knowledge of the basic constituents of nature and its laws, interactions and charges, and of the forces and fundamental fields of nature. Indeed, the current gaps of the most respected contemporary physical theories leave no doubt that there is still no unification in physics nor much hope for such a unification.

I wish, nonetheless, to support a philosophical view about the role of the interaction and integration relationships between encephalon, body and environment in the constitution of the mind. And this view depends on the use of the currently available knowledge about the structure and the physical laws of the world and the organisms that occupy it.

From here, the paper will be guided by the following

question: What can we state about the physical constitution of the world in the light of the best physical theories available?

4. WHAT THE STANDARD MODEL OF PARTICLE PHYSICS SHOULD SAY ABOUT THE BUILDING BLOCKS OF THE WORLD?

I could be satisfied with the definition — borrowed from the Standard Model of particle physics — that "the world is entirely composed of microparticles in force fields" (MOGRABI 2008, p. 17). We are now, in the year 2016, under the same conditions in which we were at the time of publication of the above reference (in 2008): the notion that "the world is entirely composed of microparticles in force fields" (i) remains problematic and (ii) demands revisions and enlargements. These two restrictions, however, should not lead us to discouragement; its limitations are not greater than its successes. My last statement is based on the continuing success of the LHC's experiments (Large Hadron Collider). Though legitimate theories are, in principle, falsifiable (POPPER 1961), I will take the particle physics — with emphasis on the current Standard Model — as the first reference source to everyone who aims to delineate the most basic constituent components of the world.

The Standard Model of particle physics is a quantum field theory that dates to 1935 — when Fermi and Yukawa respectively proposed their theories of the weak and strong interactions (NAGASHIMA 2014) — and has established itself as the Standard Model for the study of particle physics in the 1970s. This model was recently enhanced with the provisional confirmation of the Higgs boson on March

14, 2013, after its discovery on July 4, 2012 by the European Organization for Nuclear Research (CERN, former acronym for Conseil Européen pour la Recherche Nucléaire) and after its prediction in 1964 by Peter Higgs.

From the 70s to the latest advances in particle physics, including the discoveries of the bottom quark (1977), the top quark (1995), as well as the publication in 2015 of sharper images of the Higgs boson — which was possible thanks to a more precise measurement of the properties and interactions of the Higgs boson with other particles and their masses (http://home.cern/about/updates/2015/09/atlas-and-cms-experiments-shed-light-higgs-properties) — the Standard Model has been very successful in mapping almost all properties and interactions of the basic constituents of the visible matter in the universe at its most fundamental level (NGUYEN 2014). Through the identification of basic particles known and the specification of almost all its known nuclear interactions, this theory has become a reference source for the knowledge we have concerning to the structure of matter (SKINNARI 2012). Undoubtedly, the Standard Model is a theory whose explanatory success stems from the incorporation of three of the four fundamental forces which govern the interactions between elementary particles at its most fundamental level, namely: electromagnetic, strong and weak nuclear interactions. The gravitational force has not yet been included in the mathematical structure of the Standard Model. The hypothetical elementary particle which supposedly carries the gravitational force is still outside of the scope of the Standard Model, since it has not yet been confirmed in the experiments performed by the LHC (AUBIN 2015; BAMBI,

DOLGOV 2016; BARR 2014; BRAIBORD, GIACOMELLI, SPURIO 2012; CHATTERJEE 2013; CMS COLABORATION 2015; DAI 2012; KIBBLE 2013; LINDNER, RODEJOHANN 2014; NAGASHIMA 2014; NGUYEN 2014; SCHELLEKENS 2016; SKINNARI 2012; T'HOOFT 2007; WEINBERG 2004; WIESE 2010).

In its current version, considering its revisions and enlargements, particle physics deals with (i) the most basic and elementary constituents of the physical world, called fermions, corresponding to different kinds of quark (divided, in its turn, into different flavors, colors and generations) and leptons (divided into different types and generations); it also deals with (ii) the manner how these elementary particles interact through the four fundamental forces of nature, (a) electromagnetic force, (b) strong force, (c) weak force and (d) gravitational force; also with (iii) the particles responsible for the mediation of nuclear interactions, called bosons, like the (a) photons, the mediators of the electromagnetic interaction, the (b) gluons, the mediators of the strong force, the (c) W and Z bosons or intermediate vector bosons, the mediators of the weak force, (d) the Higgs boson, which is responsible for the origin of mass of elementary particles, and (e) the graviton, the hypothetical mediator of gravitational force; finally, the Standard Model of particles physics handles (iv) the antiparticles, which quantitatively correspond to most of the particles, and which are endowed with the same mass and are opposite charged with regard their corresponding particles. The complex scheme extracted from the interactions between (i) elementary particles, (ii) fundamental forces and (iii) mediator particles have been successfully explained by par-

ticle physics and by theories that revise and expand them, although, as I have said, the gravitational force and the hypothetical graviton have not yet been embraced by the mathematical structure through which it is supported the model currently adopted for particle physics, the Standard Model (MAAS 2016; RATCLIFFE 2016).

In line with the most consensual and dominant set of current theories on elementary particles, on their force fields and on their dynamic interaction, I will conceive particles as excitations of quantum fields, in accordance with quantum field theory (QFT), the theory that provides the mathematical structure for the Standard Model, and through which quantum mechanics and special relativity could be incorporated in the Standard Model (PESKIN, SCHROEDER 1995; ZEE 2010). The view of particles as excitations of quantum fields conflicts with the classical atomistic view. Consequently, I will base myself on the principle that non-atomistic explanations of matter are closer to the results of modern physics; moreover, if we consider the atomistic view whereby the material world is made up of (i) immutable and rigid atoms, on one side, and of (ii) void, on the other, we must conclude that modern physics has reached a non-atomistic point of view (KUHLMANN 2000, p. 18). The particles, moreover, may not be located at any finite region of space and time (KUHLMANN 2000, p. 152), which means that the quantum theory of fields confront several atomistic arguments, although it is still difficult to establish viable concepts of fields as the basic entities of quantum field theory (KUHLMANN 2000, p. 152). Anyway, the notion of nature as composed of bits of matter precludes our understanding of the interactive dynamics of particles interaction, since it is mathe-

matically impossible to simultaneously determine the position and movement of an electron (GREINER, 2001). Indeed, what is now understood as atoms does not refer to those entities that are candidates for "the atoms of atomism"; there is, in fact, "the possibility of a superposition of particle states with different numbers of particles"; moreover, "demonstrations for the non-objectivity of the particle number of a physical system" and of its non-localizability suggest that the theory of quantum fields puts forward evidence contrary to a classical atomistic interpretation of particles (KUHLMANN 2000, p. 149 - 151).

It is also necessary to ask the following question: Which and how many are these elementary particles from which the world — including the organisms within it — is made up? According to the Standard Model, and in compliance with the method which distinguishes particles of antiparticles, and, moreover, includes the color states and flavors of quarks and gluons, it is correct to say that, according to the Standard Model of particle physics, the world is basically composed of 61 elementary particles, which are intertwined with each other within the four fundamental forces of nature: this criterion considers 24 fermions + 24 antifermions + 12 vector bosons + 1 Higgs boson (BRAIBORD, GIACOMELLI, SPURIO 2012, p. 314). In accordance with a more direct method of particle counting, we can refer to the 17 particles that make up the set of all existing things: 6 flavors of quarks (up quark, down quark, strange quark, charm quark, bottom quark, top quark), 6 types of leptons (electron, muon, tau, electron neutrino, muon neutrino and tau neutrino), 4 gauge bosons, divided into three types (photons, gluons, W and Z bosons), and 1 Higgs boson.

There is a quite extensive literature devoted to explaining the Standard Model. The literature dealing with its limitations is almost of the same length, and it is usual that the same materials proclaim the explanatory success and, at the same time, highlight the limitations of the Standard Model (AUBIN 2015; BAMBI, DOLGOV 2016; BARR 2014; BERTONE, HOOPER, SILK 2005; BETTINI 2014; BOYARKIN 2007; BRAIBORD, GIACOMELLI, SPURIO 2012; CHATTERJEE 2013; CMS COLABORATION 2015; DAI 2012; KIBBLE 2013; KUHLMANN 2000; LINDNER, RODEJOHANN 2014; MAAS 2016; NAGASHIMA 2014; NGUYEN 2014; NYAMBUYA 2014; RATCLIFFE 2016; SCHELLEKENS 2016; SKINNARI 2012; T'HOOFT 2007; WEINBERG 2004; WIESE 2010). For this reason, it appears that although the Standard Model of particle physics is needed to support a position on the problem of the consciousness-mind-self-encephalon-body-environment relations, this model to the study of the particle physics is not complete in its proposal to hold a philosophical position about the role played by the corporality and the environment in the constitution of the mind (conscious): indeed, the role of gravity is undeniable both in the origin and effectiveness of bodily information channels, from which derives our sense of bodily self-consciousness.

In addition to the limitations regarding the non-incorporation of the gravitational interaction just like described by general relativity, the Standard Model of particle physics leaves unexplained, at least until now, some other phenomena concerning the matter and the forces of our universe. The Standard Model does not account for dark matter, covering only a small part of the known com-

position of the universe. Besides, this model does not account for the asymmetry between the matter and the antimatter observed in the universe, which limits its epistemology capability to explain what happened after the moment of the Big Bang and, consequently, its explanatory power is small with respect to evolution. Also, the discovery of neutrino oscillations has called into question the initial formulation of the Standard Model, which did not foresee non-zero neutrino masses: even with reformulations, it is difficult for the Standard Model to understand why neutrinos are so slight and tiny compared to other elementary particles. Furthermore, the Standard Model still need to handle the hierarchy problem, which consists in the significant discrepancy between the gravitational scale and the weak nuclear force of the typical phenomena of elementary particles. There is also the challenge of the spontaneous electroweak symmetry breaking (EWSB) (AUBIN 2015; BAMBI, DOLGOV 2016; BARR 2014; BERTONE, HOOPER, SILK 2005; BRAIBORD, GIACOMELLI, SPURIO 2012; CHATTERJEE 2013; CMS COLABORATION 2015; DAI 2012; KIBBLE 2013; KUHLMANN 2000; LINDNER, RODEJOHANN 2014; NAGASHIMA 2014; NGUYEN 2014; SCHELLEKENS 2016; SKINNARI 2012; T'HOOFT 2007; WEINBERG 2004; WIESE 2010). Of course, these limitations do not remove the relevance of the Standard Model, which has justifiably been called the 'theory of almost everything' (OERTER 2006; SCHELLEKENS 2016).

For my purposes, the most severe limitation of the Standard Model of particle physics lies in its failure to deal with gravitational force. Given my intention to support a theoretical position which demands both the particle phys-

ics and the gravitational force, I will depart from the Standard Model of particles with their revisions and enlargements. I will consider what is known of the gravitational force via the very gravitational theories which successfully explain the power exerted by gravity on the constitution of the living organisms from which emerges the mind (conscious). At this moment, it may be less relevant to ask for the best gravitational theory than to wonder about what we know about the influence of gravitational force in living organisms, especially with respect to organisms endowed with mental abilities.

5. CONFRONTING THE GAP OF THE STANDARD MODEL OF PARTICLE PHYSICS: IS THERE A ROLE FOR GRAVITATIONAL FORCE IN HUMAN CONSCIOUSNESS STUDIES?

Standard model of particle physics inability to to encompass gravitational interaction is undoubtedly one of the major gaps in one of the best and most legitimate contemporary theories of physics. The standard model confesses its own fragility, and therefore this gap does not imply any suspicion about the role of gravitational force in the arrangement of bodies and organisms: in fact, most quantum field theory models do not resign themselves to this limitation; almost all these models postulate a hypothetical mediator for gravitational interaction, the so-called graviton. Although their own structure and their supposed mode of existence are completely unknown, quantum field theories support the belief that the existence of a particle responsible for the transmission or mediation of gravitational force is quite plausible. Despite this common belief, gravity remains the subject of controversy among physicists. One

example of difficulty in this matter is the historical controversy between the notions of action at a distance and action by contact (or mediated action), which extends from Faraday to Einstein, including the recent demonstrations of what Einstein called *spooky action at a distance*. The difficulty of physicists is also expressed in the fact that quantum gravitation has not yet undertaken the reconciliation between general relativity and quantum mechanics.

Such a difficulty undoubtedly creates a justified skepticism about the possibility of philosophy and physics subsidizing an investigation of self-consciousness as a function of gravitational force. At this point, it is not my intention to offer an answer to this supposed group of skeptics. At this point, my goal is not to demonstrate that the key to a definite explanation of consciousness resides in the gravitational force. Rather, it is a matter of recognizing what the best theories of physics usually recognize: gravity is still recognized as one of the four fundamental forces of the universe, and more importantly, gravitational interaction is usually recognized as one of the four forces. In fact, gravitational interaction is the only one that acts universally in all matter and energy. In addition, is undeniable the force exerted by gravity in the disposition of the bodies at all moments.

In this sense, I only recognize the dominant role of the gravitational force in the physiological mechanisms behind the constitution of self-consciousness at its most primordial level. An example of this influence is the ability of the cerebrospinal fluid (CSF) — within the vestibular system — to deal with the impact generated by the gravitational force on the body, as well as its capacity to perpetrate conscious proprioceptive sensations. The recognition of the gravitational force's ascendancy over living organisms lies behind

the numerous attempts in gravitational biology to formulate theoretical models dedicated to delineating the participation of gravity in biological processes and their impact on the health and function of organisms.

One of the best-known examples of this effort concerns the quantum model of consciousness developed by Sir Roger Penrose and Stuart Hameroff (HAMEROFF 1998; HAMEROFF, PENROSE 1996; PENROSE 1989, 1994, 1996, 1997). The relevance of Penrose and Hameroff in this debate is undeniable. If my objective at this point were not to demarcate the foundations of my theoretical model, but to offer a theory of consciousness (and given the present state of physics), it would indeed be important that I formulate a hypothesis regarding the relation between the quantum fields of the elementary particles and conscious states, including a discussion of the possibility of reducing consciousness to quantum fields and the relation of gravitational force to these fields. It would be important, moreover, that I seek to account for a phenomenology of consciousness which considers the gravitational force. In other words, it would be important for me to present a theoretical framework within which the relationship or bridges between the first- and third-person aspects of the impact of gravitational force on (conscious) mental organisms were discussed, in order to account for the link between gravitational force and our conscious sense of its effects.

Given, however, that my immediate goal is to argue that the standard model of particle physics is theoretically satisfactory for my ulterior purpose of supporting a theory of consciousness based on a discussion of the 'space' occupied by consciousness in the world, it is now necessary to recognize the relevance of these discussions and to point

out the need to equate them. For my present purposes, the countless studies that problematize the role of gravity in the constitution of conscious and nonconscious mental states are of great relevance. A common research line of these studies is represented by works such as Pozzo et al. (1998) and Clément (2007). In common, these works propose to demarcate some of the most relevant participations of the gravitational force in the proprioceptive mechanisms which correspond to the most basic levels of self-consciousness. I am interested in scrutinizing the following principles: (a) the awareness of the environment implies its perception through the nervous regions dedicated to sensory and motor functions; (b) these functions are dependent on microgravity, especially with respect to sensory organs responsible for balance and sensory orientation; (c) investigations carried out in space reveal that superior cortical functions are impaired or at least radically altered under conditions of different gravitational levels; and, among others, (d) cognitive processes of spatial orientation contribute to the constitution of self-consciousness, and the way we perceive the world (which determines even how we make art and science) are crucially dependent on the gravity whose impact on the human body we can measure.

It is not wrong to claim that the limitations of the Standard Model with respect to gravity can be minimized by the fact that at the level of the minuscule scale of particles, the effect of gravity is weak enough so that we may neglect it. That is why the non-incorporation of the gravitational interaction by the Standard Model does not seem to be in principle such a severe restriction of its explanatory power (CERN, THE EUROPEAN ORGANIZATION FOR NUCLEAR RESEARCH s/d.).

For my purposes, nevertheless, this limitation is very significant. After all, the gravitational interaction is a dominant force at the macrophysical level, and therefore in the voluminous bodies, like human organisms. In a paper filled with current and prevalent arguments — although written 18 years ago — Pozzo, Papaxanthis, Stapley and Berthoz (1998) have maintained that gravity is not just a force or a load acting continuously on the body members, but it is also one of the fundamental basis of the higher-level processes of the nervous system. The role of gravity in the vestibular and proprioceptive systems establishes a reference frame of dynamic orientation of the body in space, through which are made possible our motor activities and our proprioceptive, interoceptive and exteroceptive mechanisms. Based on this understanding, Pozzo and his collaborators (1998) scrutinized a set of research devoted to mapping the role played by gravity in the coordination between posture and movement and, subsequently, in the cognitive mental functions responsible both for spatial orientation and motor planning. This research also paved the way for understanding (still in force) that, through gravitational force, our motor activities stem from the ability of the central nervous system of dynamic balance adjustment, both by the stabilization of the head in relation to the environment and in the eye-head coordination. Also, this research has resulted in a notion that remains relevant, namely, that the gravitational force is the condition of possibility for postural control in space, for planning the motor control as well as for the increasing of the adaptive effectiveness of our proprioceptive mechanisms.

The overall results of this research published in 1998 have also been obtained by the most recent studies, like the

papers published by Jamon (2014), De La Torre (2014) and, among many others, the official texts written and publicized by NASA. In common, these texts usually depart from the assumption that gravity —or lack thereof — directly interfere in many of our motor, perceptual and cognitive abilities, including postural functions, vestibular system (balance), speed and accuracy of movements, attentional and perceptual processes, detection of the member's position and, consequently, motor planning and situational awareness of the environment.

Indeed, gravity has shaped the architecture, form, and function of the biological systems, or even the very life on Earth. Moreover, it was decisive for the development of our bipedal posture. Gravity played a decisive role so that human became bipedal and so that they (we) could be in the environment in just the way bipeds perceive and explore the surrounding world. On the same grounds, the gravitational force has afforded us the conditions of interaction and integration with the environment in a different way from the ones offered to animals such as quadrupeds, creeping and crawling animals, flying and gliding animals, as well as those living in trees or any other animals which are in the world from a spatial paradigm which are distinct from ours. Gravity shaped life on Earth by providing a framework for the orientation of the body in the surrounding space. Given its ubiquity, its importance and its stability, the gravitational force has allowed that organisms have developed their specific forms of sensitivity and particular modes of insertion in the environment, their typical internal maps of the spatial navigation, their ways of maintaining balance, as well as their patterns of height, muscle mass, blood mass, bone mass, and their distinctive ionic composi-

tion and properties; in addition to all the above features, the gravitational force permanently influences the structure of DNA (DE LA TORRE 2014; JAMON 2014).

For all these features, there is no doubt that the role played by the gravitational force in the constitution of the bodily awareness is of paramount significance not only for my purposes, but for the philosophy of mind in general. Given that self-consciousness significantly involves the multiple ways in which we use, are aware or mentally represent our bodies, and given that the gravitational force is crucial for all ways of using, perceiving and representing the body, there are many reasons why we cannot neglect the gravity to support a complete philosophical position on the problem of consciousness-mind-self-encephalon-body-environment relation, particularly with regard to the investigations both on the role of corporeality (including its information channels) and the environment in the understanding of how the (conscious) mind emerges from an organism embedded in and interacting with its environment.

6. Concluding remarks

I have sought to answer the proposed hypotheses more succinctly than I wanted or expected to do when I began to plan this work. I hope, however, to have provided sufficient information for my philosophical purposes. This first paper of my theoretical project is part of the first step of my project, and its purpose, as stated earlier, is to explain and clarify the structural, methodological, theoretical and conceptual pillars on which I support a general treatment to the multiple ontological and phenomenological problems

raised by interaction and integration relationships between consciousness, mind, self, encephalon, body and environment. From a pre-defined methodology, I have tried to give an answer to the following problem: is there a role for physics with respect to the investigation of the place of mind within a world governed by physical laws? As my paper has shown, my answer to this question is positive, since we are physical organisms embedded in and interacting with its environment, which is the natural world.

In order to provide an answer to this question and to fulfill the purposes of the first among the two parts of this project, I have sought to outline what is known about the physical constitution of the world in the light of the best — although incomplete — available theories of physics, which are gathered into the Standard Model of particles physics, such as quantum field theory and its ambition to be the language that could make quantum mechanics and spatial relativity compatible to each other. Within the Standard Model, the possibility of compatibility between quantum field theory and relativity would be the most effective way of the Standard Model makes room for the long-awaited 'theory of everything'.

Physical, especially the Standard Model of particle physics, has much to teach us about the basic physical elements of our constitution. I have also explained, albeit briefly, the limitations of this model as well as the need to extend and revise its scope. I have concluded from these findings that the limitations of the Standard Model are not sufficient to mitigate their success at least with respect to my purposes. The main exception (a noteworthy one) is the non-incorporation of the gravitational force, which I sought to address in the section dedicated to the role of

gravitational force in the investigation of human consciousness.

In other words, I sought to minimize expectations regarding the incorporation of gravity. For us philosophers it is necessary to depart from the achievements of the Standard Model of particles physics and from what we know about the influence of the gravity in the constitution of the conscious mind. In this sense, I am flirting with the Physics beyond the Standard Model (BSM) without the need to scrutinize the minute details of the theories that have been appearing to fill the gaps of the Standard Model.

The structure and the matters discussed in this paper, and the role that this text performs in my project is due to my belief that the absence of a well-defined conception of the basic physical components of the world is part of what explains the multiplicity of perspectives — not often contradictory to each other — concerning to the nature and ontological status of the mind, with regard to the 'space' occupied by the mind in the natural world, with respect to its mode of appearance/onset or emergence, and, moreover, with regards to what is required for appearance or emergence of the mind.

I have now the possibility to develop, in the next text, the other grounds of my philosophical position, specifically the three basic theses of emergentism: (i) physical monism, according to which entities existing or coming into being in the universe consist solely of material parts, (ii) the existence of emerging systemic properties, an argument which holds that there are systemic properties and that the emergent properties are systemic ones, and (iii) synchronic determination of systemic properties in relation to its parts, according to which a system's properties and dispositions to

behave depend nomologically on its microstructure (STEPHAN 1998, 1999, 2004, 2006).

I have sought along these lines to roughly define what I mean by 'physical'. Consequently, I hope I have achieved more clarity regarding the understanding of the substrate/composition of the organisms from which the mind emerges.

Resumo: O presente texto é o primeiro de uma sequência destinada à consecução de um projeto que proponho empreender ao longo de duas partes interconectadas, posto que independentes. A partir do propósito que elegi para desenvolver sua primeira parte, qual seja, demarcar os pilares sobre os quais me alicerço para subsidiar o tratamento que ofereço aos múltiplos problemas suscitados pelas relações de interação e de integração entre consciência, mente, encéfalo, corpo e ambiente, busco, neste primeiro texto desta primeira parte, delinear o que se sabe da constituição física do mundo à luz das melhores teorias disponíveis da física, especialmente do Modelo Padrão de física das partículas. Ao longo do texto, busco demonstrar que, a despeito de suas limitações e lacunas, o Modelo Padrão é suficiente para meus propósitos iniciais, ainda que a força gravitacional só possa ser incorporada por meio de revisões e ampliações deste modelo. O desenvolvimento dos argumentos deste texto abre espaço para o meu próximo passo, a saber, sustentar que as teses básicas do emergentismo (monismo físico, determinação sincrônica e propriedades sistêmicas e emergentes) oferecem o melhor material disponível para a investigação do 'espaço' ocupado pela consciência no mundo natural para além das limitações dos fisicalismos redutivo.

Palavras-chave: Problema das relações consciência-mente-encéfalo-corpo-ambiente; Modelo Padrão de física das partículas; Constituição física do mundo; Monismo físico.

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