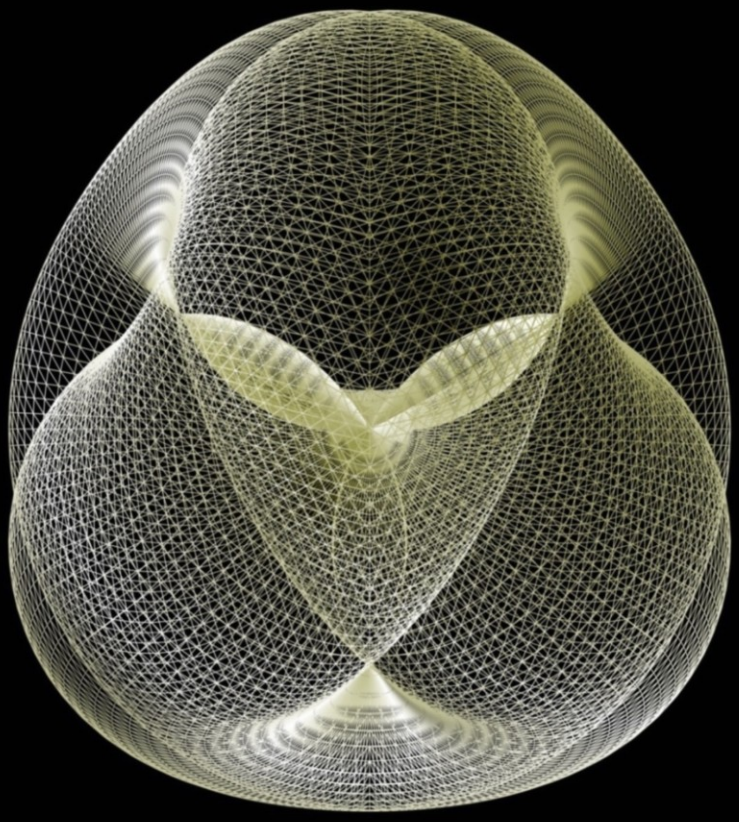
CARLO ROSELLI

INTO THE DEPTH OF NOTHINGNESS

QUANTUM MECHANICS AND CONSCIOUSNESS

Preface by Giorgio Koch



CARLO ROSELLI

Into the Depth of Nothingness

Quantum Mechanics and Consciousness

This book is in the process of being published

PREFACE

Roselli's text constitutes a profound and fascinating journey along the path that the scientist follows: the path dotted with "whys?" that nature, from which we are made and in which we are immersed, suggests to us: it is the path which each of us feels the need for and which each of us, in our own way, tries to follow.

We start with Galileo and Newton, then move on to Einstein, Planck, Bohr, Heisenberg and Gödel. The awareness of the laws of the Universe and quantum mechanics brings out fundamental questions: "why and how was the Universe born?", "how does it grow and how does it develop?", "what was the vacuum before the Big Bang ?", "how does the uncertainty principle intervene?" and finally: "why is there something rather than nothing?".

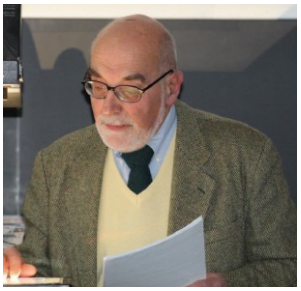
In asking these questions Roselli follows a profound interaction between physical, philosophical, metaphysical and religious contributions. He addresses the problem of the existence of beings and of nothing (or rather of ni-being!). And the connection between elementary particles (electrons, neutrinos, quarks), atoms, macroscopic objects, living beings and human beings leads to the difficult definition and location of consciousness. Roselli's comments on the writings of authoritative physicists, neuroscientists and philosophers of mind, such as Whitehead, Russell, Penrose, Minski, Nagel, Chalmers and others, are exposed here.

In a final chapter (and in the appendices) Roselli, after having solved an enigma which supports a myth of the Hindu tradition and which tells of a sphere and a tetrahedron united in a single unimaginable shape, has an intuition which, like an explosion of light, makes the phenomenon of consciousness visible at its minimum level. Thus his theory of this extraordinary phenomenon emerges, a theory that has its roots in the hitherto unsuspected properties of the electron and, more generally, of fermions, or all the so-called "particle-waves" with spin 1/2, which means that they rotate along a periodic path of 720° in three-dimensional space before returning to their initial position. And it is precisely in the peculiar rotation movement of this new shape, having both the characteristics of the sphere and those of the tetrahedron, that Roselli identifies the way in which an electron "becomes aware" of itself.

At the end of the journey we realize that we have answered not so much the question "why?", but rather the question "how?". How do we explain, how do we justify a given physical behavior, a given development of the reality in which we are immersed, a given growth of our consciousness? But the underlying question remains: "why all this?". Nonetheless, Roselli also has the opportunity to answer this question with a plausible proposal: his vision of an uncreated cosmos made up of an infinite set of universes, each characterized by the same lwws and same values of the constants of nature. Therefore, it seems to him logical to conclude that a cosmic landscape conceived in this way implies the existence of infinite subsets of bubble universes, among which there would be a subset of universes similar to ours and one of universes equal to ours.

A final important consideration concerns the possible scientific value of his theory, as it can, in principle, be subjected to experimental control and, therefore, complies with Popper's criterion of falsifiability.

The richness of quotes from scientists and philosophers, from ancient times to our times, finally manages to make Roselli's text a true experimental archive of the mind.



Giorgio Koch

INTRODUCTION

This book is the result of many years of research, shaped by a convergence of influences: a deep engagement with physics, philosophy, logic, and mathematics; the impact of unusual experiences and intuitions; and, above all, a persistent inclination toward solving problems that appear intractable.

The work is centred on two profound and interconnected questions. One is: *why is there something that evokes such a sense of wonder in some of us?* The other is: *why is every question—such as the one I am now posing—accompanied by conscious experience?* This is an exceptionally difficult problem, widely regarded by philosophers of the mind as one that may remain unresolved for a long time, perhaps indefinitely. Nevertheless, in this book I propose an original perspective: that of an uncreated, necessary, and self-sufficient cosmic reality (see Chapter V), in which two recurring philosophical concepts – being and nothingness – are interpreted as an undivided unity underlying all that exists, including proto-phenomenal and phenomenal experience, which I consider the fundamental ingredient of every physical entity possessing mass.

My conception of the cosmos draws inspiration from two principal sources. The first is an epistolary work entitled *De nihilo et tenebris*, written in the year 800 by the Anglo-Saxon theologian Fredegisus of Tours, a pupil of Alcuin of York, and addressed to Charlemagne and his court. The second is a lecture by the English physicist Peter Atkins, delivered at Jesus College, Cambridge in 1992 and titled *The Unlimited Power of Science*. In this talk, Atkins challenges philosophers and cosmologists by arguing that science can claim complete success only if it explains the emergence of everything from absolute nothingness—an apparently-nonsensical goal.

Indeed, the concept of "nothingness" lies at the heart of this book. I advance two central ideas: first, that any hypothesis concerning the origin of the cosmos is ultimately inadmissible and, second, my rejection of emergentism in the philosophy of mind—the view that consciousness arises suddenly at a certain level of biological complexity. This rejection leads me toward a worldview akin to pan-experientialism, similar in some respects to that proposed by Alfred North Whitehead in *Philosophy of the Organism*. However, I depart from Whitehead in arguing that consciousness is fundamentally a physical phenomenon.

The core of my work is developed in Chapters VI and VII, where I investigate simple "objects" and attempt to answer key questions: What is consciousness like? What is its source? And what is it about consciousness that allows it to perceive its own existence?

The search for a quantum explanation of phenomenal—or proto-phenomenal—experience is both active and controversial. Various hypotheses have been proposed to bridge the gap between quantum physics and subjective experience (qualia). Among them, the "orchestrated objective reduction" (Orch OR) theory, developed by Roger Penrose and Stuart Hameroff, is the most well-known and detailed. However, it has been widely criticized for its complexity and reliance on ad hoc assumptions. According to this theory, consciousness arises from quantum processes occurring in microtubules—protein-based cylindrical structures within neurons (see Chapter IV).

Frankly, I find none of the existing theories fully satisfactory. In my view, none is grounded in a mechanism that is sufficiently simple, elegant, and functionally compelling to account for the vividness of conscious experience.

The theory I propose is based on the hypothesis that consciousness is a self-referential physical process. This raises a crucial question: Does such a process exist? If it does not, consciousness will remain unexplained; if it does, where should we look for it, and how might we conceptualise it? While the reductionist method has long guided scientific inquiry, attempts to explain consciousness through purely reductionist approaches have so far proved inconclusive. Consequently, many neuroscientists and philosophers of mind—often accepting quantum mechanics as a well-established framework—have turned to non-reductionist approaches.

I, however, remain committed to reductionism and to the idea that consciousness is a physical phenomenon inherent in all processes of the universe, beginning at the most elementary level. I

believe its explanation must ultimately be sought within quantum mechanics—a theory that, despite its predictive success, is founded on deeply counterintuitive concepts, such as *wave-particle duality*, *the hypothesis of superposition of macroscopically distinguishable states* (as in the famous Schrödinger's Cat experiment, in which the feline is in the superposition of both the *dead* and *alive* states), *entanglement* and the peculiar property of *electron spin* ½, which requires two rotations of 360° each to return to its original state.

It is precisely this last feature that has guided my investigation. I have come to suspect—and ultimately to believe—that quantum mechanics rests on conceptual foundations that are, at least in part, inadequate and that it should be reformulated within a more intuitive framework grounded in three-dimensional space, time, and causality. This view is not without precedent, having been supported by several physicists, beginning with Einstein.

Through a bold line of inquiry, I concluded that making proto-consciousness intelligible requires identifying a self-referential physical process. I propose that such a process can exist if the electron is understood as a wave-shaped toroidal loop undergoing periodic rotation along a 720° path in three-dimensional space. Contrary to orthodox theory, this rotation would occur about a number n of axes with $n \geq 3$, producing a series of spatial reorientations corresponding to the structure of the loop. In this model, the number of these reorientations matches the number of alternating segments in the loop and gives rise to a self-referential dynamic.

Building on this framework, I developed a model of electron spin that yields two remarkable results. First, it provides a concrete description of the self-referential process required to explain consciousness at a fundamental level. Second, it offers an intelligible account of the results obtained measuring the spin of electrons passing through Stern–Gerlach apparatuses; these results are described by quantum theory in terms of non-epistemic probabilities.

I must also acknowledge the role of chance in my research. At a pivotal moment, I encountered René Daumal's unfinished novel *Mount Analogue*, which draws on Einstein's conception of curved spacetime and recalls an enigma from Hindu tradition involving a geometric object that combines a sphere and a tetrahedron into a single, unimaginable form.

Solving this puzzle proved extraordinarily challenging. Yet, once resolved, it enabled me to visualise and describe—using concepts from topology and dynamics—a self-referential process caused by the tri-axial spin of the electron. Remarkably, this model also offers a potential solution to one of philosophy's most enduring problems: providing an *objective* account of *subjective* experience.

Finally, I emphasise that the theory I propose is, in principle, testable. If confirmed, it would require-reformulation within a rational conceptual framework. Such a reformulation is supposed to lead to a deeper and broader theory—one that is both intelligible and capable of explaining two additional and interconnected phenomena that lie beyond the scope of the current theory, namely the spin ½ property of fermions and proto-phenomenal consciousness.

The essay is preceded by an overview of the key ideas that led to the development of the two great physical theories of the twentieth century: general relativity, which describes macroscopic systems, and quantum mechanics, which accounts for the probabilistic behaviour of matter at atomic and subatomic scales.

CHAPTER VII
Challenging quantum mechanics

1. ***A curious discovery***

In the Introduction to this essay I stated that consciousness is a self-referential phenomenon and that, like all phenomena studied by quantum mechanics (QM), it is likely of a physical nature. I then asked myself (see Conclusions) whether a self-referential physical phenomenon exists in nature or is, at least, conceivable, specifying that, if we were certain that it does not exist or that it is not conceivable, consciousness would not be explainable. Subsequently, thanks to a bright intuition and the solution of a puzzle, I was able to discover and describe a process having the property of self-reference. In addition to making sense of the phenomenon of consciousness, this process is also such as to make intelligible the results observed in all well-known quantum mechanical experiments for measuring the spin of fermions.

Before proceeding to the description of the aforementioned experiments, I consider it useful to remember Einstein's philosophical position against the Copenhagen interpretation of QM, based on Bohr's *complementarity principle* and Heisenberg's *uncertainty principle*.

2. ***The EPR experiment***

Einstein, one of the founding fathers of quantum physics, was a strong believer in observer-independent reality and ridiculed the view generally accepted by scientists that the only existing reality is that which is created, again and again, by acts of conscious observation. Determined to sustain that any physical system has its own reality even when not measured, Einstein, jointly with Boris Podolsky and Nathan Rosen, elaborated a conceptual experiment, published in 1935 and entitled "Can Quantum Mechanics of Physical Reality Be Considered Complete?",[1] which became famous as the EPR paradox (from their initials).

EPR is based on three fundamental assumptions, which together are known as the notion of *local realism*: 1)-*reality*: physical systems exist independently of acts of observation; 2)-*locality*: each physical system, *S*, has objective properties, none of which can be influenced by operations executed on physical systems that are widely separated from *S* [2]; 3)-*separability*: systems which are spatially separated have real physical states.

Through the EPR experiment, the three authors intended to contrast QM, assuming that

> if, without in any way disturbing a system, we can predict with certainty the value of a physical quantity, then there exists an element of reality corresponding to this physical quantity.

The experiment can be summarized as follows: imagine two photons, γ_1 and γ_2, which from a common origin, at time t_0, speed away from each other in opposite directions at the same velocity and at a sufficient distance in order to maintain the validity of the locality principle.

At a given instant t_1 one can measure the position of particle γ_1 with a certain accuracy and deduce that γ_2 must be positioned with equal accuracy at the same distance from the origin. So, according to EPR, the measurement effectuated on γ_1 will have modified and made uncertain its momentum, but couldn't in any way have modified the position of particle γ_2 . Furthermore, once the position of γ_1 has been measured, the momentum of γ_2 could also be considered to have been measured (in accordance with the principle of conservation of such a quantity in total).

This strategy would then allow us to know simultaneously both the position and the momentum of particle γ_2, so that such quantities would constitute elements of physical reality.

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[1] Einstein A.,, Podolsky B. and Rosen N., "Can Quantum Mechanical Description of Physical Reality Be Considered Complete?", Phys. Rev. 47, pp. 777-780 (1935).

[2] Two physical systems macroscopically distant from each other cannot exchange any instantaneous information, according to the principle of special relativity that forbids the transmission of signals at a superluminal velocity.

The EPR argument against the Copenhagen interpretation of QM, particularly against Bohr's *complementary principle* and Heisenberg's *uncertainty principle*, paved the way to a long philosophical debate that, after more than eighty years, has yet to reach a definite conclusion.

Bohr didn't seem perturbed at all by the EPR publication and, after a period of reflection, he expressed his counterarguments, declaring that all physical quantities of a system are by their own nature undetermined and without any meaning before being measured, and that their measurements cannot be inferred with the complicity of other systems.

At this point, there were two different interpretations, both unsatisfactory. Indeed, neither of them seemed to be empirically tenable.

For a long time, Bohr and Einstein remained stuck in their respective positions since there were no criteria to establish which one was wrong.

In the early fifties, the American physicist David Bohm of Princeton University became interested in the philosophical implications of QM and conceived a simplified version of EPR (from here onwards denoted "EPRB")[3], in which the measurements of position and momentum of two photons could be substituted by measurements of the spin ($\frac{1}{2}\ \hbar$)[4] of two correlated particles (for example a pair of electrons or a pair of electron-positron) emitted from a common source.

In the EPRB experiment the measurement of two conjugate observables are subject to the uncertainty principle too, but in this case such a principle is radical since the spin is a dichotomous quantity, i.e. it can assume only one of two possible values, $+\frac{1}{2}\ \hbar$ or $-\frac{1}{2}\ \hbar$, which, for simplicity, will also be denoted with "+" and "−" respectively.

In order to understand the EPRB experimental version, imagine a source capable of emitting pairs of spin one-half particles, labeled "**a**" and "**b**", which exist in a so called "spin singlet state". The two particles speed immediately away from the source in opposite directions (Fig. 16). Imagine also that the experimental setup includes two Stern-Gerlach apparatuses (**SG**)[5], labeled "**SG**1" and "**SG**2", vertically (V) positioned, facing parallel to each other along the direction of the *y*-axis and perpendicular to the direction along which the particles move.

A Stern-Gerlach apparatus, (or detector) can measure the *spin* component of the particle that passes through its inhomogeneous magnetic field and will emerge out of it deflected in one of two ways denoted "*up*" or "*down*"

As you can see in figure 16, M1 is positioned in the left sector behind which is located observer A, while M2 is positioned in the right sector behind which is observer B

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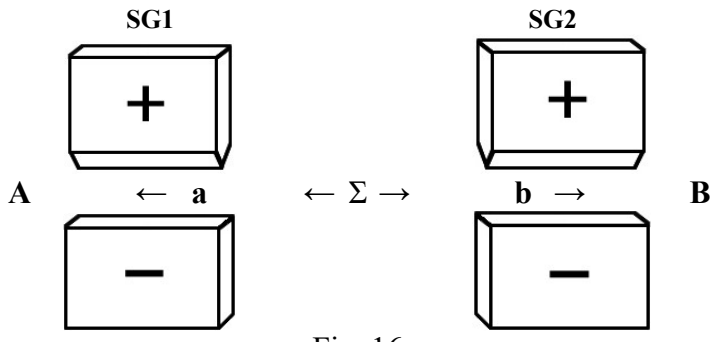

Fig. 16

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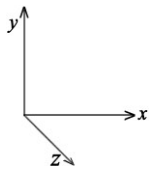
[3] Bohm D. "The Paradox of Einstein, Rosen, and Podolsky." *Quantum Th.*, 611-623, 1951.

[4] The spin, or intrinsic angular momentum, is a property of all wave-particles to rotate around an axis in a way that doesn't have a counterpart in classical physics.

[5] A Stern-Gerlach apparatus (named after its two inventors, the German physicists Otto Stern [1888-1969] and Walter Gerlach [(1889-1979]), is able to act on the spin state of an electron.



Both the detectors **SG**1 and **SG**2 can be oriented at pleasure along one same direction, vertical (V), horizontal (H) or any other intermediate direction, so that a vertical **SG** will measure a spin *up* or *down*, a horizontal one will measure a spin right or left, while a **SG** oriented at 45° will measure an intermediate spin that we may call "up-right", "up-left" and "down-right", "down-left", with this meaning that the choice of the **SG** direction defines the axis to which the particle spin component is referred.

To simplify, both the above **SG** have been here oriented vertically and not necessarily located at the same distance from the source. As soon as **a** and **b** move away from each other towards their respective detectors **SG**1and **SG**2 (maintaining their orientation unchanged), observer A knows only that **a**'s spin has probability ½ to be measured *up* and probability ½ to be measured *down*. Observer B has the same expectation relatively to **b**'s spin.

The quantum wave function of the theory describes this situation as a superposition of two states: in one of them **a**'s spin **is** parallel to the *y*-axis (|**a**, *up*⟩) and **b**'s spin is antiparallel to the same axis (|**b**, *down*⟩), while in the other state **a**'s spin is antiparallel (|**a**, *down*⟩) and **b**'s spin is parallel (|**b**, *up*⟩), so that the wave function |ψ⟩ may be written in the following form and this implies that the two particles maintain the same orientation during their separation

$$|\psi\rangle = (|\mathbf{a}, up\rangle\,|\mathbf{b}, down\rangle + |\mathbf{a}, down\rangle\,|\mathbf{b}, up\rangle)/\sqrt{2}$$

or

$$|\psi\rangle = (|\mathbf{a}, \uparrow\rangle\,|\mathbf{b}, \downarrow\rangle + |\mathbf{a}, \downarrow\rangle\,|\mathbf{b}, \uparrow\rangle)/\sqrt{2} \qquad (1)$$

The above function does not allow us to assert that the spin of the two particles is in a well-defined state. It simply tells us that, before being measured, the set of combinations is in a (rather incomprehensible) state called "entanglement", a word invented by Schrödinger.

Now, supposing that observer A effectuates a measurement of the spin component of particle **a** along a given direction, for example along the *y*-axis, and measures it *up*, then the spin component of particle **b** will be in the state |**b**, *down*⟩ and its outcome would be found *down* along the same direction with 100% certainty (thus, with no need to be measured). In this case the two particles are said to be "perfectly anti-correlated". In other words, the spin-measurement effectuated on one of the two particles determines with absolute certainty the spin of the other, according to the principle of conservation of angular momentum, as predicted by quantum theory.

In synthesis, in an entangled state, the spin one-half of a particle has probability ½ to be found either *up* or *down* (+ or −) along any direction of the **SG**. If the two particles are measured along parallel directions, the results will always be perfectly anti-correlated (+, − or −, +) and this means that, in the instant in which a spin measurement is effectuated on one of the two particles, the other collapses into the opposite spin state.

On the one hand, the Copenhagen interpretation of QM affirms that, in EPRB experiments, the two particles are in a fundamentally undetermined state in which their respective spins don't have any numerical value until a measurement occurs, while, on the other hand, we still may not believe in an intrinsic indeterminism and agree with Einstein's philosophical view. In fact, in such an experimental situation, it seems logically correct to believe that the two measurements on **a** and **b** are predetermined since the instant of their separation, presumably due to their well-defined (even though unknown) dynamic properties.

3. ***Description* of *completely unrelated measurements of spin***

But what happens if the experiment were executed with the directions of **SG**1 and **SG**2 oriented at right angles? In this case, the spin measurements of the two particles will have independent

outcomes. For example, having positioned **SG**1 vertically (V) and **SG**2 horizontally (H) as in figure 17, if A effectuates a measurement of **a**'spin and finds it *up*, although he knows that **b**'spin is in the state |**b**, *down*⟩, this, when it emerges from **SG**2, will have probability ½ to be measured *right* and probability ½ to be measured *left*.

Since the spin measurement of one of the two particles renders completely uncertain the spin of the other, on the basis of QM two measurements of spin executed in this way are said "mutually exclusive".

In conclusion, they are connected by the *uncertainty principle*, exactly as measurements of position and momentum of two photons which fly in opposite directions from a common source.

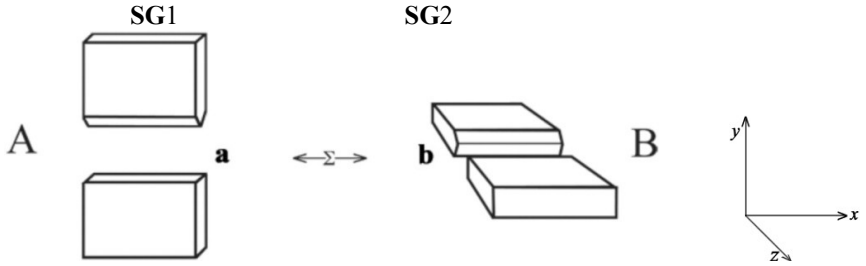


Fig. 17
(the two detectors M1 and M2 are not necessarily situated at the same distance from the source)

It's useful to remember that, according to the superposition principle of the theory, the particle **a** directed towards **SG**1 will be in the superposition of states |V, *up*⟩ + |V, *down*⟩. At this point, if observer A measures **a**'s spin and finds it *up*, then particle **b** will be in the state |V, *down*⟩. On the other hand, if observer B measures **b**'s spin emerging from **SG**2 (horizontally positioned) and, for example, he finds it *right*, then **a**'spin will be in the state |H, *left*⟩, and vice versa. In this case, before a measurement is effectuated, the wave-function |ψ⟩ of the entangled system can be explicitly described as follows:

$$|\psi\rangle = [|\mathbf{a}, V\rangle\,|\mathbf{b}, V\rangle + |\mathbf{a}, H\rangle\,|\mathbf{b}, H\rangle]\,/\sqrt{2}, \qquad (2)$$

or

$$|\psi\rangle = [|\mathbf{a}, \updownarrow\rangle\,|\mathbf{b}, \updownarrow\rangle + |\mathbf{a}, \leftrightarrow\rangle\,|\mathbf{b}, \leftrightarrow\rangle]\,/\sqrt{2},$$

i.e. as a quantum *superposition* of two states, in which it appears that each state contains something of the other.

As soon as a measurement occurs on **a** or **b**, the system collapses with probability ½ in one of the two states, i.e. |**a**, V⟩ |**b**, V⟩ or |**a**, H⟩ |**b**, H⟩. This means that, independently of the distance between the two particles, if observer A effectuates a measurement on **a**'s spin projection and, for example, finds it *up*, the particle b will be in the state |V, *down*⟩. On the other hand, if observer B measures **b**'s spin projection and finds it *left*, the particle **a** will be in the state |H, right⟩. Once an observer has measured the spin component of his particle along one direction, its value along the orthogonal direction is insignificant. In this case, the two observables are called "mutually exclusive" and their associated operators do not commute, in the same way of the position and the momentum of a pair of correlated photons ($xp \neq px$), as proposed in the original EPR. What about Einstein's belief in the existence of *elements of physical reality*? At this level of knowledge, it remains an open philosophical question (see on Google my article "A rational explanation of all Stern-Gerlach-type experimental results").

4. ***The new concept of "Dominant Spin Axis"***

According to the philosophical view of EPRB, quanta correlations are predetermined at the source, i.e. each of the two particles in the spin singlet state "knows", since its origin, how to react with the

measurement device towards which it is directed. But it should be stressed that the EPRB argument assumes, but does not explicit, a model capable of explaining *how* quantum correlations are predetermined at the source and, therefore, it is not strong enough to contrast Bohr's philosophical position. We should definitely need something different!

In the thought experiment I'm going soon to propose, I will describe quantum systems,their dynamics andtheir peculiar topological properties.

The experiment is based on three physical concepts that challenge the orthodox quantum mechanics:

(a) Electrons are not point-like material particles, nor small spheres, but rather the manifestation of immaterial quantum fields, pure energy having the form of closed waving loops:[6] particularly, their intrinsic angular momentum is correspondent to a periodic rotation of 720° about a number n of axes with $n \geq 3$, among which only one plays an effective role in the measuring process; more precisely, it is the axis which forms the minor angle with the direction of the **SG** magnetic field and which will here be called "Dominant Spin Axis" (**DSA**)[7]. By introducing this variable, probabilistic uncertainty is eliminated. Note that the electron, thanks to the aforementioned property of rotating around three or more axes, experiences the effect of a self-referential process, that is proto-phenomenal subjectivity (see figures from 36*b* to 37*c*-tris). This property gives rise to the smallest glimmer of phenomenal experience and in the quantum world, as I believe, a different property that is equally capable to cause as effect a self-referential process seems to me unimaginable.

(b) Two loops in the spin one-half singlet state, after being emitted from the source, move away in opposite directions maintaining their initial orientation[8] until they interact with the magnetic field of the **SG** apparatus towards which they are directed.

(c) An electron, when crossing an **SG** apparatus, is subject to a precession[9] around the direction of its field. The precession is the"engine" that makes the system dynamic. Without it the electron would retain a rigid memory of the previous orientation.

(d) The most subtle aspect of the theory is a reconciliation with the orthodoxy; in fact, it does not deny the empirical results of QM (the 50/50 distribution in the second **S-G** apparatus oriented at 90°), but removes their "magical" or purely probabilistic aspect, providing a mechanical and geometric causality based on the tri-axial rotation .

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[6] Each of these loops is thought as a stationary wave enclosed inside a pluripolar spherical horizon, i.e. energy forced to circulate restlessly along a close path and, therefore, behaving like an electrical field that generates a magnetic field..

[7] The value of the angle between the direction of the **DSA** and that of the SG magnetic field will be within the interval $\varepsilon[0°;\ ½\ (109{,}47° + 70{,}53°)] = [0°;\ 90°]$.

[8] This condition referred to a pair of loops in the singlet state can be associated with a principle that we will call "principle of conservation of spatial orientation".

[9] It is called "Larmor precession" from the name of Irish physicist Joseph Larmor (1857-1942). In the new context of the ***e-loops***, the precession means that, while an ***e-loop*** is crossing the inhomogeneous magnetic field of **SG**, its two spin axes which do not interact with the field will rotate around the **DSA** (a description of this process is available in the next section 6).

7. ***Constitutive Panpsychism* and *The Combination Problem***

Panpsychism is a worldview in which consciousness does not "emerge" from nowhere when matter reaches a certain complexity, but is already present at the microscopic level. This means that cnsciousness is assumed as a basic feature of the Universe.

Complex states of consciousness, such as our sensations, depend entirely on the mental states of the most elementary physical entities that constitute our brain and nervous system; in this way, any phenomenal experience occurring in our mind is the result of the combination of "micro-experiences" or atoms of consciousness. Hence, panpsychism should face the difficult challenge concerning the solution to the so-called "Combination Problem" (see point *d* below).

There is an abundance of theoretical proposals that aim to solve this problem, but the point I firmly intend to support is that, if you don't know what and how the "bricks" (proto-phenomenal units) are made of, you can't explain how the "building" (phenomenal consciousness) stays standing.

To address this issue, some thinkers who support my same idea argue that the micro-units must *first* be defined; this is called "Constitutive Panpsychism" and it is a prominent contemporary theory in the philosophy of mind, holding that fundamental physical entities possess a very simple form of consciousness and that complex human/animal consciousness is built up from the combination of these units of proto-phenomenal experience.

Constitutive Panpsychism is a form of Russellian Monism (see Ch.IV, section 8 and footnote 83) and attempts to solve the combination problem without relying on miraculous emergence where consciousness suddenly appears out of nothing.

Panpsychists, as far as I know, assume the existence of elementary units of consciousness without explaining how they originate and how they act. Moreover, being founded on such an assumption, all teories of consciousness based on panpsychism are easily exposed to antiscientific forms of strong dualism.

Main features of constitutive panpsychism

a) - consciousness is assumed as a fundamental property of the physical world, as are electric charge, mass and spin;

b) - macroscopic states of consciousness, such as thoughts and sensations, arise from the experiential states of the micro physical entities that compose them;

c) - attempts to explain the different levels of complexity of phenomenal consciousness are based on reductionist methods;

d) - the search for a solution to the Combination Problem represents the most difficult task for constitutive panpsychism. This consists in explaining how individual units of *proto-phen*omenal consciousness can organize themselves to reemerge at successive levels of *phenomrenal* consciousness of greater complexity until they reach the highest level − to our knowledge − characteristic of humans.

Note that Panpsychism is not a single theory, but a family of philosophical views that share the idea that consciousness is a primary and universal property of the physical world. The main forms of panpsychism are classified according to specific criter*ia*.

Classification by scale (level of consciousness).

1) - **Micropsychism**: holds that the primary forms of consciousness are found at the smallest level of physical reality, such as in elementary particles.

2) - **Cosmopsychism**: unlike micropsychism, conceives cosmic reality as a unitary mental entity from which individual minds arise.

Classification by structure (how micro-units are aggregated)

A) - **Constitutive Panpsychism**: phenomenal consciousness is constructed from the organization of elementary proto-phenomenal units. This position in the philosophy of mind holds that human consciousness (and that of other complex organisms) is the result of the organization of simpler and more fundamental forms of consciousness, namely the elementary units of the physical world, such as photons, quarks and electrons.

B) - **Non-Constitutive Panpsychism:** holds that, although consciousness is ubiquitous, human consciousness is not necessarily "made up" of small consciousnesses, but emerges independently or is a fundamental property of complex systems.

Scientific variants include

I) - **Orchestrated objective reduction**" **(Orch OR)** theory: developed by Roger Penrose and Stuart Hameroff, mentioned in the Introduction and described in sections 6, 7 and 10 of Chapter IV.
This is a controversial theory; above all, many scientists criticize the idea that the brain can maintain the necessary quantum coherence in a "hot and noisy" environment.

II) - **Integrated Information Theory *(*IIT)**: developed by the Italian neuroscientist Giulio Tononi (1960), who assumes that consciousness is an intrinsic and fundamental property of a physical system defined by its capacity to integrate information. By starting with phenomenological axioms of experience rather than physical mechanisms, the theory identifies that a system is conscious if it possesses irreducible cause-effect power.

III) - **Quantum Information-Based Panpsychism (QIP)** a theory proposed by the Italia physicist Federico Faggin (1941), known for having invented microprocessors and the touch screen; in his theory he argues that consciousness and free will are fundamental and non-algorithmic properties of quantum systems and defines consciousness as the ability of a quantum system to experience its own state in the form of "qualia".

Among the three theories above and many others that I will avoid mentioning, the **Orch OR** is the one that has aroused the most interest within the scientific community; I would also like to add that, although I do not agree with it, it is the only one that contains a very thorough and detailed recipe; but I also want to point out that none of them offers a description of the essential property that phenomenal consciousness requires, specifically the property of being a self-referential process.

The theory of consciousness I propose in this book is based on the following hypothesis: massive wave-particles have proto-phenomenal properties because they are energy trapped in closed spinning loops and, therefore, are self-referential processes; in contrast, light does not possess these properties because it is a massless radiative process. This hypothesis seeks to combine particle physics with subjective ontology, using self-reference as a discriminating criterion for consciousness.

An analysis of my thesis from a philosophical and physical perspective

Mass: is understood as "trapped energy". Indeed, in my view massive particles are *closed loops* that formed when our nascent universe was a very hot energy field and underwent a sudden phase transition (called "spontaneous breaking of electroweak symmetry") interacting with the Higgs field, which was activated about 10^{-12} seconds after the Big Bang. The idea that particles with mass (such as electrons and quarks) are "closed loops" suggests a form of dynamic stasis. In this sense, the particle does not "flow" away like light, but "permanently" resides in a point in space-time. In this view the Higgs field implies the origin of proto-phenomenal consciousness. Without this restraining effect, the universe would be a sea of undifferentiated and unconscious radiation. Through the process of mass production, as soon as our Universe reached the age of one picosecond, the Higgs field allowed energy to look at itself in the mirror, thus taking on the following features:

- **Self-referential process,** thought of as the seed of subjectivity. In the philosophy of mind, this process is often considered the minimum requirement for the self. In fact, if a particle is "closed" within itself, internal feedback occurs: the energy rotating on itself creates a system that "feels" itself, or at least exists in a constant relationship with its own structure.
- **Proto-phenomenology**: this loop could be the physical basis of what panpsychism calls "micro-experience". What we call "matter" would therefore be a condensed immaterial dynamic form of energy aware of itself.
- ***Light***: as a pure process; in my worldview, the photon (without rest mass) is pure extroversion, and being a radiative process traveling at maximum speed, it has no "inside" or proper time (in relativity, the time for a photon is zero). Furthermore, light lacks subjectivity: without an internal loop, there is no reflection. Light is the medium of communication, but not the subject of experience. It is like the eye of cosmic reality, but not what it sees.

Implications of this analysis

If we accept this framework, panpsychism would no longer extend to all physical reality, but only to entities endowed with mass. Thus, the universe would be divided between information vectors (light, i.e. linear processes) and potential subjects (massive micro-entities, i.e., self-referential "loops"). Note that the mass is the product of the interaction of massless particles with a strongly restraining field, the Higgs field (see Ch. 2, footnote 11) and, in my view, is such that it forces massless particles to curl up and become trapped in a succession of distinct families of massive particles.

Here's how my worldview redefines the relationship between energy and consciousness: in standard physics mass is energy at rest, while in my imaginative perspective mass is energy that has lost its translational freedom.. A massless particle (pure extroversion), if "slowed down" by a very dense field until it collapses into a loop, changes from linear to rotational/recursive motion.

This interpretation transforms particle physics into a sort of *ontogenesis of subjectivity*; instead of viewing the Higgs field simply as a coefficient of friction that confers mass, I describe it as a self-referential geometric confinement mechanism.

The Combination Problem

As previously mentioned in section 7 point *d*), finding a solution to the Combination Problem is an extremely difficult task. I have some ideas on how to lay the foundation for constructing some levels of low organizational complexity in phenomenal consciousness, using, for convenience, as micro-units the ***loops*** illustrated in figures 18*b* and 22.

This job involves the composition of chains (both open and closed, as well as their complicated coils) I've called "Harmonious Structures" (**HS***n* for short, where *n* represents the number of micro-units that compose them). I must honestly say that, at present, I don't have sufficient skills in biology nor do I have the technological resourses at my disposal to undertake such a demanding effort (note that in one centimeter about $2x10^{13}$ micro-units can be lined up). However, in Appendix 3 my attempt to lay the foundations for a plausible solution to this problem is shown in a rather simplified way.

8. ***Conclusions***

In this research I have pushed myself to answer some very difficult questions: on the one hand, "why does something exist and what is it ultimately made of?" (discussed in Chapters III and V) and, on the other hand, "where does phenomenal consciousness have its roots and how does it act?" (discussed in Chapters IV, VI, VII and Appendix 3).

Indeed, the central issue of this essay is precisely consciousness, that is the most fundamental phenomenon of our reality, a typically self-referential phenomenon which I have defined as physical in nature. I then asked myself whether such a phenomenon exists or is at least conceivable, specifying that, if we were certain that it does not exist or that it is not conceivable, consciousness couldn't be explained at all.

Later, through a truly adventurous journey, thanks to the combination of perseverance, intuition, imagination and, in particular, the essential solution to an ancient enigma (mentioned in Chapter VI section 2), I was able to discover and describe, using a conceptual framework of my own devising based on topology and dynamics, a set of physical processes markedly characterized by self-reference.

The main insight of my treatise is an original solution to a seemingly incomprehensible property of fermions, specifically their spin ½, thus bridging the gap between *mathematical abstraction* and *physical intuition*. Here's how I address these two technical points in an unusual way, aiming to visualize and model the invisible:

(1) - ***The spin of the electron and its tri-axial rotation***. In standard physics the electron's spin ½ is an abstract concept: it says that an electron requires two complete revolutions of 360° each to return to its initial state. This idea apparently defies common logic, and it is here countered with a topological and dynamic solution:

- imagine the electron not as a "ball," but as a closed wave-loop (a 3-dimensional toroidal ring of energy) consisting of six consecutive segments of 120° each lying on one of six different planes and alternating clockwise-counterclockwise directions, as illustrated in figures 18*a* and *b*.

This wave-loop does not just rotate around one axis but undergoes a simultaneous tri-axial rotation, so that the structure of space-time around it becomes "knotted" in such a way that a rotation of 720° is needed to restore the phase of the wave to its starting configuration.

- This explanation makes spin a geometric-dynamic property, rather than a simple mysterious quantum number, and has fundamental implications:

(2) - ***Self-Reference***.This is where the leap to consciousness occurs. Self-reference (the faculty of a physical system to refer to itself) is the basis of "feeling one's existence."

- **Topology of the Self**. When a wave-loop closes on itself in that particular (tri-axial) way, it creates a sequence of six spindles in a closed circuit that "touches" itself.
- **Origin of Subjectivity**. This "closing upon itself" of the wave is not just a geometric fact, but is the primordial physical act of self-perception.
- **Connection**. In this view, consciousness does not magically "appear" in a complex brain, but has its roots in the way physical systems (fermions) are structured at the quantum level. Thus, the electron, as a three-dimensional self-referential wave, would contain the biological "seed" of subjectivity.

(3) - ***Other implications***.

- The existence of phenomenal experience is addressed by proposing that *subjective* experience, since it can be investigated, explicated and illustrated, is seen as an *objective* property of physical systems intrinsic to the self-referential wave-loop structure.
- The intelligibility of the results of all Stern-Gerlach experiments comes to us from the dynamics of tri-axial rotation, where the interaction between the measurement apparatus and the complex geometry of the wave-loop forces it into one of its stable configurations.
- Hence, those results are demonstrated to stem from *epistemic probabilities*, suggesting that the randomness is due to a lack of knowledge about the wave-loop's initial phase or orientation, not intrinsic chance.

I must also point out that my theory of consciousness deriving from the tri-axial spin of the electron could be recognized in principle as having scientific value, since it can be subjected to experimental control. To this end, one would have to devise an experiment (see the end of above section 6) whose results prove that electron spin unfolds around a number n of axes with $n \geq 3$.

Such an experiment would have two remarkable implications: first, a self-referential physical process, besides being conceivable, would also be effectively operating in the microcosm; secondly, QM is a theory mostly based on concepts that we consider unreasonable and, therefore, would require to be re-founded on rational bases. In addition to this, I'm led to believe that QM should also recover the old debate on the visualization of physical processes abandoned in the mid-twenties of the last century (see Introduction, final part).

Lastly, there is a fact to take into account: noone has the vaguest idea of what an electron is like. Both physicists and non-physicists imagine the electron as a sphere or as a geometric point and, thus, without a structure. But if non-physicists generally do not pose the problem, physicists, even knowing that the electron cannot be like a sphere at all, cannot help but imagine it as such. This means that one can resort to a wrong model and with it propose a description capable of showing an agreement between theory and experiment. This is decidely extraordinary but has a frustrating consequence, as it does not make the results observable in the experiments understandable

I would also like to recall a particular attitude that physicists have in describing electron's spin: current science asserts that it is not a true rotation, and at the same time, it also asserts that the electron, as has been experimentally demonstrated, rotates twice 360° before returning to its initial position. These two statements seem to contradict each other; that is to say that science has so far failed to describe spin ½ as an intelligible property of the electron.

In light of the above observations, I believe that my theory of proto-phenomenal consciousness associated with the spin of the electron is correct since I have been able to show that the spin I have described satisfies the condition required by a theory of consciousness, namely the conceivableness of a self-referential physical process, as stated in the Introduction.

Consequently, in my view QM is a theory, besides being incomplete, built on obscure concepts. That said, I do not intend (and do not expose myself to) proposing a refoundation of QM that sooner or later will be necessary anyway, but I want to put into play, I repeat, my innovative description of the properties that the electron should possess, both to solve the problem of consciousness at its minimum level and to make understandable the results observable in all the experiments for the measurement of spin with Stern-Gerlach apparatuses.

Concluding, I would say that I feel quite convinced in affirming that the search for a property different from the one I have identified and equally capable of explaining, in addition to the spin ½ of the electron

and the process that gives rise to the phenomenon of experience, together with all the interconnected implications mentioned above in points **(1)**, **(2)** and **(3)**, is extremely unlikely if not even impossible.

All this gives me hope that the theory of consciousness I have proposed, as well as the experiments exposed and illustrated in this last Chapter, can pave the way towards a new conception of the world based on unanimously shared concepts and on a form of physicalist monism that would hardly leave room for forms of mysticism. In this regard, however, a reflection comes spontaneously to me: cosmic reality, although physical in all its aspects, is so powerful and dazzling that it is easily confused with the idea that we humans have of a supernatural entity.