The roles ascribed to consciousness in quantum physics : a revelator of dualist (or quasi-dualist) prejudice[1]

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Introduction

Let's ponder two simple questions : "how can consciousness interact with physical systems, thus imposing a reduction of their quantum state ?" ; or, conversely, "how can consciousness be produced by a process involving physical systems described by quantum theory ?".

The purpose of this paper is not to offer an answer to these questions that were raised by some of the best physicists of the twentieth century, from Eugen Wigner to Roger Penrose, but rather to ask more questions. Why did so many serious thinkers considered that they were legitimate questions at all ? What are the implicit ontological and epistemological presuppositions that underpin this sense of legitimacy ? Can we move upstream such presuppositions and adopt a standpoint from which these questions would no longer be taken at face value, but rather as symptoms of a conceptual and cultural bias ?

1. Sense, non-sense, and philosophy

This strategy that consists of asking questions about questions, instead of addressing them straightaway, can be perceived as a dodge. But it is in line with one of the most specific tasks of philosophy. Indeed, "what truth and falsity is to science, sense and non-sense is to philosophy" [1]. Even before trying to solve a problem by scientific methods, one should try to inquire philosophically into whether this problem makes sense at all, or at least under which intellectual (or existential) conditions one is prone to *believe* that it makes sense. If pushed far enough, and with sufficient boldness, this inquiry may lead up to overturning the system of presuppositions that made the problem acceptable in the

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first place. In the present case, as we will soon realize, such overturn is tantamount to adopting the standpoint of *phenomenology,* a philosophical discipline that deliberately favors a first-person approach of any issue dealing with what there is and what can be known.

2. Tacit presuppositions

So, what presuppositions are hidden under the former questions about the relation between consciousness and quantum mechanics ? In fact, these questions encapsulate virtually *all* of the presuppositions that guided the research effort of the West from the seventeenth century until now. They do so with such compactness that they turn out to be precious revelators of our common cultural background, provided we do not fall immediately under their spell.

To start with, our two initial questions involve a pair of terms: consciousness and physical systems (or processes). These terms having the grammatical status of substantives, they irresistibly call for the vague intuition that there are two "substances" that relate to each other, or interact with each other. Isn't it natural "to try to find a substance for a substantive", as Wittgenstein suggested in the very first page of his *Blue Book* [2] ? One may refrain from falling immediately in this elementary trap, but the structure of the question makes the mental attractor of dualism almost irresistible in the long run. Even the archetypal opponent of dualism in the contemporary debate, namely physicalist monism, is not immune from this. Indeed, physicalist monists deny that consciousness *exists* independently of the neural processes. By saying so, physicalist monists implicitly accept that consciousness is something that may exist or not exist in the same sense as physical objects, and they thereby render themselves guilty of virtual dualism.

To sum up, the two major protagonists of the present debate in the philosophy of consciousness, namely (property or substance) dualists, and physicalist monists, share two presuppositions.

The first presupposition is that consciousness is either something or a property of something. Dualists consider that such something has an independent form of existence, and that it can act somehow on physical systems and processes; whereas physicalists try to understand how the property "consciousness" can emerge somehow from physical systems and processes.

The second presupposition (that is the reciprocal of the first one) is that there exist physical systems and processes apart from consciousness.

3. Phenomenology beyond presuppositions

But are these two presuppositions unavoidable ? The phenomenological tradition has disposed of them long ago.

According to phenomenology, consciousness is no thing or property that may exist or not exist. "Consciousness" is the misleading name we give to the precondition for any ascription of existence or inexistence. What makes this remark obvious for phenomenologists and almost incomprehensible for physicalists, is that phenomenologists are settled in the first-person standpoint, whereas physicalist researchers explore everything from a third-person standpoint. From a first-person standpoint, anything that exists (thing or property) is given as a phenomenal content of consciousness. Therefore, consciousness *de facto* comes before any ascription of existence.

Instead, from a third-person standpoint, nothing else than objects of perception and handling is to be taken seriously. Now, the behavioral or neurobiological correlates of consciousness are possible objects of perception and handling. They can be said to exist (if a subject is alive and awake) or not to exist (in other cases). Then, from this standpoint, saying that the neural correlate of consciousness (often taken as its "neural *basis")* may exist or not exist, amounts to saying that consciousness itself may exist or not exist in the same sense.

Let's now turn our philosophical attention on the second presupposition, that is the keystone of physicalist monism, but that is shared by dualism. What is the status of the tacit assumption that there *exist* physical systems and processes apart from consciousness? From the third-person standpoint, this is just a fact, that is so glaring that it hardly needs arguments apart from an evocation of common sense. But from the first-person standpoint of phenomenology, this is a bold metaphysical assumption that stems from the "natural attitude" of common sense and extrapolates far beyond it. We have already mentioned that, according to the phenomenological approach, it is *prima facie* obvious that physical

objects are given as nothing else than correlates of conscious experience. They arise as poles of stability and identity within a flowing consciousness ; they are meanings constituted through consciousness, or intentional correlates of acts of consciousness [3].

Physical objects can still be said to “transcend” consciousness according to phenomenology, but in a sense that is itself rooted in certain features of consciousness. This is what Husserl called “the immanent transcendence” of the objects of our experience in §48 of his *Cartesian Meditations*.

The first feature that evokes transcendence is the fact that physical objects are presented *incompletely* to consciousness at each moment : one just perceives one facet of an object at a time and expects other facets, or one just measures one variable pertaining to a physical system and predicts (deterministically or probabilistically) the values of other variables. This gives rise to the impression that there is still more to come, that a physical system has always something additional in store beyond what appears of it at this very moment. But one must not forget that this feeling of incompleteness is itself generated by an even more primitive act of consciousness : the act of *identifying* past, present, and expected appearances as moments of one and the same object [4]. Once this act of identification has been performed, our ever-developing expectations are understood as a sign of the incompleteness of our knowledge *about this enduring object*.

The second “transcendent-like” feature is that expectations may be disappointed ; that a surprise may occur. This is usually expressed by saying that physical systems are *given* to us, since we do not “control” how they manifest to us. But translating this “givenness” into standard ontological terms, asserting that physical systems are “external” entities of a “reality out there” which is completely foreign to their appearances in conscious experience, is a dubious inference. From a phenomenological standpoint, this ontologization of the “givenness” and transcendent-like behavior of certain patterns of experience is just a verbal trick used to favor the intersubjective stabilization of the poles of identity and intentional directedness that structure the field of consciousness.

4. A phenomenological critique of the concept of “physical system”

Let's notice at this point that the lack of ontological import of the concept of physical system in phenomenology makes the redefinition of the putative objects of physical theories much easier. It invites us to see the existence of physical objects as an open problem rather than an uncontrovertible fact. And it then prepares us for the most radical scientific revolution of all : a revolution in which not even the former ontological furniture of the world can subsist. To understand this, we must come back to the (mostly tacit) criteria we use in order to convince ourselves that a certain phenomenon is underpinned by a permanent entity *of which* it is the appearance. These criteria were described in exquisite details by Husserl [4] from a phenomenological standpoint, and also by Piaget [5] from the standpoint of developmental psychology. Piaget summarized his criteria thus : "(A child) does not believe in the permanence of an individual object as long as she cannot find it again and again by coordinated actions". The key criterion for believing in an entity is active *reidentification*. But in microphysics, reidentifying a localized object with certainty is usually impossible (as can be inferred from considerations about Heisenberg's "uncertainty" relations, or about quantum statistics). It then turns out that the class of objects "localized particles", and more generally "spatio-temporal continuants", is highly problematic in microphysics [6].

Yet, physicists still speak in terms of independent "physical systems" having "states", *on which* various (mostly incompatible) measurements are performed. Can the general concept of "physical system" truly survive its most common variety ; can it survive the disappearance of the (more or less) localized individual particles ? Probably not. Some good reasons to think that not even the general concept of "physical system" can be left untouched by the quantum revolution, were given recently [7]. These reasons pertain to the structure of sets of experimental phenomena : certain sets of measurement outputs are *not* such that they can be *ascribed to* single physical systems. The provocative conclusion is that "physical theory may contain no physical systems" [7]. It thus turns out that a physical theory such as quantum mechanics might well be averse to the second common presupposition of dualists and physicalist monists. Physics no longer supports physicalism (at least not without contrived attempts to save it).

5. Quantum physics without physical systems

But then, what status can we ascribe to quantum mechanics, if we cannot even say that it provides us with a non-standard *description* of *physical systems* ? Some suggestions to that effect were made long ago by Bohr, when he wrote that "physics is to be regarded … as the development of methods of ordering and surveying human experience" [8], and that quantum mechanics is "… a purely symbolic scheme permitting only predictions … as to results obtainable under conditions specified by means of classical concepts" [9]. The two key words here are "human experience" and "predictions": a physical theory like quantum mechanics provides us with probabilistic predictions bearing on a fraction of human experience that measurement devices help to shape into elements of experimental information. Similar ideas were further developed in neo-Bohrian circles. Some authors explicitly suggested that quantum mechanics bears on nothing else than pure information [10]. Other authors considered that quantum mechanics is just a probabilistic "user's guide" for agents confronted with the outcomes of their own experimental and technological activities [11].

In other terms, according to the latter authors, experience comes first, and a physical theory is a coherent bundle of expectations about its later developments. This puts physics in line with elementary animal and human cognition, thereby weakening the common belief that physical theories have something exceptional, that they represent a historical leap due to their innovative use of a combination of rationality and technology. Indeed, according to phenomenology, the essence of human condition is to live in the perspective of one's own *possibilities* of being/becoming, and never to remain trapped into flat factual actualities. The essence of human condition thus implies a permanent anticipation of what will come next, a projection of oneself onto an expected future [3]. Similarly, according to some significant naturalistic views, the function of cognition is to anticipate by certain bodily capacities and behaviors those features of the environment that are relevant for the survival of cognizing organisms. In particular, the function of the nervous system is to minimize the disruption of expectations, i.e. to attenuate the "surprises" of an organism confronted with accidental variations of its environment [12, 13]. This being granted, the previously mentioned neo-Bohrian approaches turn out to be an epistemological golden standard for quantum mechanics.

Indeed, according to them, quantum mechanics no longer appears as a maverick theory, but, on the contrary, as one of the purest expressions of a central principle of knowledge, and one of the most straightforward formal extensions of a basic function of elementary cognition.

6. What must be assumed for the measurement problem to make sense ?

Now, how does this relate to the measurement problem, which was the main motivation for the disconcerting introduction of consciousness into physics ? As a preliminary to answering this question, we must make an inventory of the *conditions* under which the outcome of Von Neumann's quantum theory of measurement is seen as an enigma or a paradox. Let's remind that, according to Von Neumann's theory of measurement, the global "state vector" of the large system made of an object and a measurement apparatus becomes an *entangled superposition* after the measuring interaction has taken place. The enigma or paradox then derives from the apparent contradiction between this superposed "state" and the sharp observational state of the measurement chain.

However, for this apparent contradiction to arise, three assumptions must be made, tacitly or overtly [14] :

1. Quantum mechanics *describes* the *state* of physical systems
2. The state of *every* physical system is ruled by quantum mechanics
3. There *is* nothing but physical systems

The first assumption is tantamount to adopting a *scientific realist* reading of quantum mechanics ; the second assumption asserts the *universality of quantum mechanics* in the domain of physics ; and the third assumption asserts the *universality of physics* in the domain of what there is (this is "physicalism").

7. Solving or dissolving the measurement problem ?

Three main strategies to solve or dissolve the measurement problem can be elaborated by renouncing each one of the three assumptions in turn. These strategies almost exhaust the

propositions that have been made during the history of quantum physics.

1'. If one renounces the realist interpretation according to which certain vectors in Hilbert spaces describe the "(quantum) state" of something, the measurement problem is automatically *dissolved*. Indeed, there is no immediate contradiction between a sharp observational state and a (superposed) symbol that does *not* represent the state of anything. There can be no conflict of this kind if the latter symbol is just taken at face value, namely as a mathematical tool used to calculate the probabilites of sets of measurement outcomes arising in various experimental contexts. This is the reason why Bohr was unable to see a problem in the so-called "measurement problem". And this is also how several contemporary physicists dissolve the measurement problem : by considering "state" vectors as relational rather than monadic symbols, or as a mathematical expressions of the best strategy for gambling about interrelated sets of measurement outcomes.

Thus, according to Carlo Rovelli [15], it makes no sense to ask what the state of a system *is* in absolute terms, since each quantum state reflects the *relationship* between a physical system and another system playing the role of an observer. There is no state *of* a system, but only relative states. Relative to someone who has made no observation yet, the state of the large system made of an object and a measurement apparatus is a superposition ; and relative to someone who has observed the screen of the apparatus, the state is sharp. But there is no fact of the matter as to which of these two "states" (superposed or sharp) *is* the *intrinsic* state of the large system.

The same dissolution occurs when vectors in Hilbert space are supposed to have nothing to do with states, not even relational states, and are rather taken as "user's guides" for making coherent bets [11].

2'. The measurement problem can be *solved* if one considers that standard quantum mechanics somehow lacks universality in the physical domain. Indeed, in this case, some physical systems may escape the general process of entanglement and dissemination of state superpositions, that is typical of the quantum theory of (measuring) interactions. And they can accordingly impose the sharp definition of their own properties to quantum physical systems. In history, Bohr's insistance that measuring apparatuses should (to a certain extent) be described by classical concepts, was

the first variety of this claim of non-universality of quantum mechanics. Later on, the same kind of claim has been systematized as a clause of distinction between theoretical and meta-theoretical entities [16]. But the claim of non-universality has also taken more conservative forms, in approaches that extend the domain of physical entities, properties, or processes beyond standard quantum mechanics. This is the case of Bohm's hidden variable theory, and Ghirardi-Rimini-Weber spontaneous collapse theory.

3'. Another strategy to *solve* the measurement problem is to accept that there exists something non-physical that automatically eludes the laws of quantum physics, and might therefore be able to break the unended chain of entanglement and superposition of "states". It is at this point that consciousness may irrupt, and we will then concentrate on the meaning and scope of this third line of thought.

8. An interlude : decoherence

Before we proceed on the theme of consciousness as a non-physical "*deus ex machina*" for solving the measurement problem, however, a brief mention of decoherence must be made. For decoherence seems to fall outside the previous classification of strategies used to address the measurement problem. But is it so ?

The decoherence solution to the problem raised by the gap between the quantum domain of superpositions and the classical domain of sharp properties is called "environment-induced superselection" [17]. The principle of this solution consists in showing that the phase coherences of the state vector (or density operator) of an apparatus correlated to a micro-system are rapidly diluted in its environment. Indeed, the virtually complete disappearance of the interference terms is equivalent to a superselection rule which only retains the eigenstates of a given observable.

This looks like a completely new kind of solution. But there are aspects of decoherence that resonate with each one of the three former strategies. We could even say that the reason why decoherence does not fit squarely with any one of these strategies is that it borrows something from all of them. Let's examine this threefold resonance in a different order with respect to the listed strategies.

Firstly, to derive a decoherence process from the evolution of a global state vector, one must split the latter into three sub-states

ascribed respectively to a micro-system, an apparatus, and an environment. But this neat separation into sub-systems does not arise *a priori* from quantum mechanics ; it may become approximately acceptable only *a posteriori,* at the end of the decoherence process. Trying to derive decoherence from quantum mechanics by postulating such separation from the outset thus looks like *a petitio principii.* But it's no longer a *petitio principii* if the postulate of separation is ascribed a meta-theoretical, rather than theoretical, status. Decoherence thus borrows something from the second strategy : it implicitly denies the exhaustivity of *quantum theory* by making use of meta-theoretical assumptions in the physical domain.

Secondly, unlike the standard "reduction of the state", the decoherence process does not yield a single eigenstate of some observable (corresponding to a single measurement outcome) but an (improper) statistical mixture of eigenstates [18]. Selecting a particular eigenstate is arguably an additional extra-physical act, since its only justification is one's awareness of the actual measurement outcome. Therefore, the decoherence approach is not completely immune from the third strategy that consists in denying the exhaustivity of *physics*.

Thirdly, if one wants to avoid the latter consequence, an option is to suspend any reference to the actual measurement outcome. But this can be done only by considering that the status of quantum symbols is exclusively probabilistic; that they always bear on possibilities and never on actuality. In this case, the decoherence process must be interpreted as nothing more than a transformation of the predictive probabilistic structure, from a quantum interferential structure to a classical Kolmogorovian structure. This is tantamount to renouncing a realist reading of the state vector as the description of something, and accordingly a realist reading of decoherence *qua* "emergence of a classical world from the quantum world". Something of the first strategy is here creeping in : dissolving the measurement problem by a non-realist interpretation of quantum symbols. Indeed, decoherence deals with a purely probabilistic aspect of the measurement problem, and discards the rest of the problem which is the issue of how a unique measurement outcome is actualized. It concerns the predictive structure of quantum mechanics, and has no relevance for its alleged descriptive status.

9. Consciousness as an extraphysical gimmick, and the phenomenological deflation

Let's now come back to the third strategy for addressing the issue of actualization : suspending physicalism. To begin with, what about the (loose) words we have used until now to state what physicalism is, and what it would be like to suspend it ? Physicalism has been roughly characterized as the claim that physics is universally valid in the domain of *what there is*. Suspending physicalism then means assuming that there is *something* that is not physical. Hence the dualist idea that, in addition to physical entities, there might be some vague non-physical stuff called "mind" or "consciousness" ; and the correlative claim that the irruption of this non-physical stuff might explain the disruption of the law of evolution of quantum physics by way of "state reduction". The trouble is that, in addition to its well-known metaphysical weakness, such dualistic option is a non-starter from a phenomenological standpoint.

To understand this, remember that phenomenology goes upstream from established ontologies to identify the elementary criterion that allows us in practice to believe that something belongs to the domain of *what there is*. This phenomenological criterion of *being* is that the pattern of expectations which shapes our concept of something is *fulfilled by a perceptual content of experience*. In phenomenology, *to be* is to appear, or at least to have the possibility of appearing. According, e.g., to Heidegger [19], "being means appearing". From this criterion it may easily be inferred regressively that experience, the most specific component of consciousness, *is not something* ; experience *does not belong to the domain of what there is*. This sounds paradoxical, but becomes almost obvious after a little reflection. Experience is not presented in experience, for it coincides with presentation itself. Experience fulfills no expectation, for both fulfillments and expectations are experienced. Therefore, experience is not something, and does not belong to the domain of what there is. Does it follow that experience is nothing at all ? By no means, since experience is the universal precondition for anything to be considered as existent ! We could summarize what has just been said by diverting a remark of Wittgenstein [20] : "(experience) is not a *something*, but not a *nothing* either !". However, this remark is weaker than the conclusion of phenomenology, which could be expressed thus :

"(experience) is not a something, but it's more than anything else, since it is *in it* and *by it* that the existence of anything is ascertained".

10. Transcendental ego and introspection

This exterritorial status of conscious experience, which phenomenology insistantly brings out, played an important role in the reflection of some quantum physicists of the past. It is often said that a whole lineage of physicists, von Neumann, London & Bauer, Wigner, Stapp, etc. advocated the idea that the state vector reduction is triggered by consciousness. But in this list, only the two last authors were unambiguously dualists, dealing with consciousness as if it were something non-physical. Von Neumann and London & Bauer were much more nuanced, sometimes coming remarkably close to a phenomenological vocabulary and approach. Even Everett, as we will see later on, can be understood as a crypto-phenomenologist.

Let's start with von Neumann [20]. His key sentence is : "But in any case, no matter how far we calculate – to the mercury vessel, to the scale of the thermometer, to the retina, or into the brain, at some time we must say: and this is *perceived* by the observer". According to von Neumann, the measurement problem would not be solved by just invoking some physical event that occurs in the brain of the observer at the end of a measuring interaction. For such event would remain "inside the (quantum) calculation" and would therefore do nothing to break the chain of entanglement and superposition. But von Neumann does not make use of some non-physical entity either. What he mentions is only a change in the level of description, between the superposition and the sharp eigenstate. From a neutral mode of description, one switches to a situated mode of description. To a view from nowhere, one substitutes a view from somewhere (or rather for someone). A quantum entangled superposition (involving the system and anything correlated with it) holds for anyone who would like to anticipate probabilistically a measurement outcome, whereas a sharp state holds for someone who has observed this outcome and wants to take it into account for anticipating the outcomes of future measurements. No miracle occurs here, but only a change in one's self-ascribed epistemological status : from anonymous predictor to specific observer, from a neutral stance to a situated view. Both

state vectors (superposed and sharp) can be used alternatively by one and the same person, according to her needs: either providing a weighted list of possible experiences available to anyone, or indicating the actual experience of someone who happens to be oneself.

This non-substantialist construal of observers and their consciousness is confirmed by von Neumann's use of the quasi-Husserlian expression "abstract ego" (Husserl would have written "transcendental ego"). According to von Neumann, the divide between the observer and the observed system can be moved back further and further until nothing (not even a brain) is left on the observer's side. It can be moved until the observer is represented only by her "abstract ego", whereas all the rest is treated as a global (quantum) system. This procedure clearly precludes any reification of the observer's residue. What is left on the observer's side is no *thing,* even though it is not *nothing*. In other terms, the expressions "Abstract ego" or "transcendental ego" do not refer to some non-physical entity. They play the role of the indexical "I", that does not refer to anything or anyone [21], but indicates the source of every act of reference.

A similar conclusion can be drawn from London and Bauer's famous analysis of the measurement problem [22]. London and Bauer give priority to the act of becoming aware, not to some reified concept of consciousness. According to them, the transition from a superposition to a reduced state vector expresses a change of perspective. The entangled superposition holds from an external standpoint, whereas the reduced state holds from the internal standpoint of an observer who partakes of the measurement chain. The said observer does not need to make a measurement (which would be a sort of self-measurement) in order to know her own state. It suffices for her to resort to the privileged relationship she maintains with herself through her "faculty of introspection". By realizing immediately and non-observationally (through this faculty of introspection) that she is in a definite state, she can "(...) constitute by virtue of her (self-)observation a new objectivity by attributing a new state to the object: (an eigenstate of the observable)". To sum up, it is not necessary for an observer to approach herself indirectly from outside (*qua* brain or reified consciousness) to get *knowledge* of herself. Some kind of direct self-knowledge is available, and this radical change of approach and angle of view is sufficient to break the quantum superpositions

that hold in the standard approach, namely from the usual (external) angle of view. This alternative approach is what London & Bauer try to convey with their use of the term “introspection”. But this term is ambiguous insofar as it connotates the “inspection” of some inner realm, thus assuming a kind of dualism of the subject and object of inner knowledge. It would be better to use the expression “knowledge by acquaintance” as opposed to “knowledge by description”. One knows the superposed entangled state vector of a measurement chain by description, but one finally knows the observed outcome of a measurement by self-acquaintance. Here again, both modalities of knowledge hold for the same concrete situated person, but with two different stances : the stance of an anonymous predictor, and the stance of an individual observer becoming aware of the outcome of a particular measurement.

11. The phenomenological flavor of Everett’s interpretation

Surprisingly, the same ideas were suggested (though cryptically) by a physicist who declared that his interpretation of quantum mechanics is “realist”, and who insisted that neither consciousness nor the “abstract ego” have any role to play in it. This physicist is Hugh Everett. Yet, his crucial move consists not so much in adding one more element to the measurement chain (an observer or, may be, a recording robot), but rather in appending a new symbol to it. The new symbol is a “memory bracket”, that contains a list of measurement outcomes observed and recorded in the past. There are as many memory brackets as there are terms in the entangled superposition of the global state vector of the measurement chain. So, each memory bracket is supposed to hold *relative to* the corresponding term. In the many-world meta-interpretation of Everett’s interpretation, this relativity is made even more concrete by a daring reification. There, each memory bracket holds *within* the world that corresponds to this term.

However, the mere addition of a symbol to each term of the superposition is not sufficient by itself to solve the measurement problem, since no collapse is triggered by it. What really does the trick in this (or these) interpretation(s) is the *situated meaning* ascribed to the symbol “memory bracket”. The measurement problem is arguably solved when one endorses one of the two following statements :

a) "In *this* universe (where *I* live), a sharp outcome *appears* to be obtained, even though in the multiverse there *is* a superposition"
b) "From *my* observer's point of view, it *appears* that a sharp outcome has been obtained, even though from the standpoint of distantiated predictors, the initial superposed state still holds".

So, the solution of the measurement problem here arises from full awareness that one occupies an idiosyncratic situation, and that this situation self-manifests in one's conscious realization of some particular measurement outcome. Here again (as in von Neumann and London & Bauer) consciousness *does nothing* to the physical world. Instead, the physical world is *reinterpreted as* what is either predicted or observed from the standpoint of a conscious agent. And this dual reinterpretation of the physical domain, as (i) that about which predictions are made after having been triggered according to the prescriptions *of conscious agents* and (ii) what is observed *by conscious agents,* is entirely encoded in a superposed state vector with memory brackets.

Turning an alleged "realist" interpretation of quantum mechanics such as Everett's into a phenomenological interpretation may sound surprising to some. But even John Bell [23] found a phenomenological reading of Everett compelling in view of the latter's "replacement of the past by memories" (with a strong critical undertone, however, since Bell accordingly accused Everett of "radical solipsism" : solipsism of *present experience*).

12. QBism and phenomenology

However, the most consistent phenomenological approach of quantum mechanics is presumably QBism [24]. QBism is an acronym for "Quantum Bayesianism" or "Quantum Bettabilitarianism". In QBism, "state" vectors are probabilistic valuations, in a Bayesian sense. They are not statements about what is the case, but statements about what each agent can reasonably expect to be the case. Ultimately, they are just expressions of subjective guesses; they express subjective agent's willingness to place *bets* about each outcome. Hence the expression "Quantum Bettabilitarianism".

What makes QBism so close to phenomenology is that it adopts a deliberately first-person standpoint (be it first-person singular or

first-person plural). The project of both phenomenology and QBism is to reconstruct the so-called objective knowledge, starting everything anew from the first-person standpoint of knowers and an agents. Just as any good phenomenologist, a QBist thinker suspends judgment about a presumably external domain of objects. Her act of suspension resembles what Husserl called the *epochè*. Indeed, in QBism, the symbols of quantum theories do not refer to objects nor do they denote predicates of objects. And, since the attention of QBists is no longer absorbed by claims about object, it is reflectively redirected towards the epistemic function and the practical use of the symbols of quantum mechanics. QBists then point out that the symbols of quantum mechanics are primarily used by agents to assign probabilistic weights to the outcomes of experiments, so that such agents can make consistent bets. Pictures of objects can still play a role in QBism, but only as ancillary mental scaffoldings helping researchers to determine the best possible use of probabilistic valuations. This further reflective move is similar to what Husserl called the *phenomenological reduction*.

13. QBism without measurement problem

The measurement problem is addressed in this spirit. About Wigner's friend so-called "paradox", QBists do not invoke consciousness (neither Wigner's nor his friend's) to reduce the state vector of the measurement chain. However, the reason why they don't need to invoke consciousness as a *deus ex machina* is not that they believe the state vector reduction describes some completely autonomous "physical process out there", thus making consciousness irrelevant for it, but rather the opposite. According to them, the quantum "state" has no direct bearing on physical processes ; it is a symbolic tool within "a calculus for gambling *on each agent's own experience*" [25]. This entails that (i) the reduction of the "state" represents no "physical" process, and (ii) conscious experience is the universal presupposition of the quantum "gambling", rather than some additional ingredient. Then, in QBism, there is no "objective reduction of the physical state", triggered by the allegedly non-physical consciousness. Even less is there the possibility of generating consciousness by this non-existent "objective reduction". In QBism, there is only a change in expectations (the dispositions to bet) that takes into account

previous experiences of measurement outcomes.

We can go as far as saying that in QBism, quantum symbols bear exclusively on experiences. They bear on their being expected or their being felt, on their being conceived as possible or their being sensed as real, and nothing else. Therefore, the fact that Wigner (who is outside the laboratory) does not use the same state vector as his friend (who is inside the laboratory), is not due to some spooky action of the friend's consciousness on the physical furniture of the laboratory. It is due to a difference in the informational basis on which those two researchers endowed with conscious experience rely for elaborating their optimal bets about future experiences. "One statement refers to the friend's potential experiences, and one refers to Wigner's own" [25]. Since nothing else than conscious experience is involved in the symbols of quantum physics, no action of conscious experience on something else must be called for to account for sudden changes in these symbols.

14. QBism beyond idealism and instrumentalism

Does this necessarily imply some sort of solipsism, or subjective idealism ? By no means. No particular subject is able to create the experienced outcome of a measurement. And no subjective preferences are involved in the probabilistic anticipation of an outcome. Each outcome comes as a partial surprise ; it is *given*. And each anticipation, each bet, is framed by rational rules of coherence that ensure (in virtue of the Dutch book theorem) its effectiveness in the long run.

Claiming that "nothing else than conscious experience is involved in physics" would be shocking only for those who believe that conscious experience restrictively concerns some inner realm distinct from the outer realm of physical objects and events. In other terms, it is shocking only under the latent presupposition of dualism. But within the framework of phenomenology, the same claim is almost trivial, and does not have the (absurd) consequence that only the inner realm exists whereas the outer realm is inexistent. For in phenomenology, what there is, namely *appearance* or *experience,* is neither inner nor outer, but present. From the first-person standpoint of phenomenology, it is obvious that the so-called "outer" objects are always tinged of experience : they are either manifest or imagined, or dreamt, or conceived. In

experience, in its anticipatory thrust and in its surprises, one finds all the resources to develop physics, with no need to take the metaphysical concept of a "real world behind the veil of appearances" too seriously. For even this metaphysical concept can be seen as one more aspect of experience : it affords representations that guide and motivate felt expectations, and it offers a background against which one can evaluate the meaning of unexpected experiences. The only particularity of physics, compared to ordinary knowledge, then lies in a tight feedback loop connecting its expectations to the technological activity that allows one to test them, through these heuristic representations.

To avoid the pitfall of pure instrumentalism or idealism, Christopher Fuchs has adopted a metaphysical position that fits quite well with the low level of ontological commitment of QBism. This metaphysical position has been called "participatory realism", thus immediately displaying that it is a (non-conventional) variety of realism. The idea behind it, is that the insuperable dependence of the symbols and propositions of quantum theories on our situation and experience *indirectly* reveals the nature of reality. Here, reality is so deeply entangled and holistic that our knowledge of it can only be participatory rather than representational, predictive rather than descriptive. Reality is so entangled that it cannot be described directly by a physical theory, but only suggested indirectly by the failure of descriptions and the use of pure predictions instead.

But how can such alternative metaphysical picture of reality "from nowhere" fit with the primacy of experience, and first-person standpoint (from somewhere), that were advocated in the epistemological presentation of QBism ?

15. "Participatory realism" and Merleau-Ponty's embodiment

Quite surprisingly, the two standpoints can easily be put in agreement. This was shown long ago by a lineage of phenomenologists stemming from Maurice Merleau-Ponty. These Merleau-Pontian phenomenologists start from first-person experience, in line with the principle of their discipline. However, when they have performed the *epochè* (or suspension of judgment), they dig into their experience to reach a particular level of it that is especially relevant for the issue of participancy. This level is the sense of *embodiment,* the experience of being-in-a-body. It

provides one with full awareness of a most remarkable item called my "own-body", whose "flesh" is simultaneously perceived and perceiving. A celebrated example, developed by Husserl and Merleau-Ponty is that of my hands : my right hand can be touched and thereby perceived (say by my left hand), but it is also capable of touching, and thereby perceiving, anything else. The latter experience of a bifacial flesh is both commonplace and stunning. It is commonplace because each one of us was born with it. And it is stunning because, through it, we witness what it is like to be coextensive with a fraction of the world. Since we are coextensive to a fraction of the world, we can but oscillate between detachment (when we perceive our own body) and radical commitment (when we realize that our own body is perceiving everything, including itself).

According to Merleau-Ponty, far from being a marginal epiphenomenon in a massively non-sentient universe, the experience of embodiment is paradigmatic. It is the only fact that fully illustrates the nature of this universe of which we partake : a highly integrated and entangled universe endowed with a potential for self-realization and self-objectification that is fully accomplished in us and through us, human beings. Merleau-Ponty then does not shy to endow this experience of participancy with a bold cosmological significance. Drawing the consequences of his deep *epochè,* Merleau-Ponty suspends even the process of positing boundaries between bodies, and accordingly describes one's own flesh in continuity with the rest of what appears. This particular bodily flesh is then considered as a locus of intense self-revelation of what Merleau-Ponty calls the "flesh of the world": "Where should we locate the boundary between the body and the world, since the world *is* flesh?" [27]. It turns out that embodiment is precisely where the cosmological concept of participancy meets the phenomenological concept of consciousness. Feeling embodied is the most immediate experience of universal participancy we can have.

16. Illusory separations in a non-separate world

But then, how did we come to believe in a separate world ? And what happened in quantum physics to remind us so strongly of our participation in the universe ?

We came to believe in a separate world through a process that is

coextensive to our life. I called it "self-objectification", but it is even more primitive than the act of objectification that is performed by language and science. Heidegger considered that self-separation *defines* our existence, and he called it the "ek-stasis" : the fact for us to be always out of ourselves, trying to project into the future or to reflect upon the past. Sartre insisted that, for us, "existing (from the latin *ex-sistere*, to stand out of oneself)" means that we never content ourselves with being what we are, but constitutively tend towards what we have to be and what we hope to reach [28]. As for Michel Henry, he bluntly asserts that "Consciousness is none other than the form of existence that arises in the *tearing of Being",* or that "Consciousness is nothing but the self-alienation of Being" [29]. In other terms, consciousness is consciousness-of-something, not because the universe is made of things and consciousnesses (nor things producing consciousnesses), but because consciousness arises *qua* self-splitting of what there is.

Now, how did quantum physics weakened this far-reaching process of separation and revive the idea of participancy ? Imagine, Bohr writes [30], that we attempt to "orient oneself in a dark room by feeling things with a stick. When the stick is held loosely, it appears to the sense of touch to be an object. When, however, it is held firmly, we loose the sensation that it is a foreign body, and the impression of touch becomes immediately localized at the point where the stick is touching the body under investigation ". According to the latter option, the blind cane becomes part of our own body when it is held firmly. The locus of our separation from the rest of the world is then pushed far from our skin, at the tip of the stick. Something similar happened with experimental devices in the era of classical science. An experimental apparatus could easily be taken as a sort of prosthesis that extends our bodies (either as an extended hand or an extended eye) and helps us reach new types of objects. Indeed, the phenomena taking place at the tip of such apparatus obeyed the rules Kant assigned for constituting a (close or remote) domain of objective knowledge.

But these rules are no longer in effect in the domain of microphysical phenomena. Deterministic causation is suspended in the spatio-temporal domain, and the concept of "substance" (or spatio-temporal continuant) is no longer applicable. Then, experimental devices can no longer be taken as prostheses that open up a new realm of objects before us ; they have not managed

to achieve the neat splitting operation that is necessary for complete objectification. With no complete separation between our devices and the environment they are meant to explore, the concept of participancy imposes itself. It is true that one could still maintain a separation between our bodies and the device (by due analogy with the stick when it is held loosely), or between a proximal and a distal part of the device. However, this alternative separation now sounds arbitrary. Bohr soon noticed this arbitrariness when he insisted that part of measurement apparatuses *must* be described classically, to allow partial objectification and sufficient grip for our language : but which part, at which level ? Participancy then becomes the norm, and the subject-object cut appears as a problem, a relic of the past, or an expedient tool.

Conclusion

To finish with a very short epilogue, I will ask two dualist questions and propose two non-dualist answers.

Do we need consciousness to reduce the state of physical systems? *No,* since "reduction" is the name we give to a revision of conscious expectations, and "physical system" is the synthetic name we use for a coherent set of consciously expected phenomena.

Can consciousness arise from a physical process such as the alleged "objective reduction"? *No,* since physical processes are nothing else than objects of consciousness, and consciousness is the flux of the self-splitting of what there is into perceiving and what is perceived, expecting and what is expected, subjective existence and its objective targets.

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