Between physics and metaphysics: a discussion of the status of mind in quantum mechanics*

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Abstract

We discuss the 'Consciousness Causes Collapse Hypothesis' (CCCH), the interpretation of quantum mechanics according to which consciousness solves the measurement problem. At first, it seems that the very hypothesis that consciousness causally acts over matter counts as a *reductio* of CCCH. However, CCCH won't go so easily. In this paper we attempt to bring new light to the discussion. We distinguish the ontology of the interpretation (the positing of a causally efficacious consciousness as part of the furniture of reality) from metaphysics (the metaphysical character of that consciousness). That distinction allows us to map the philosophical theories of consciousness compatible with quantum mechanics under the tenets of CCCH. Also, it indicates that the problem will have to be discussed at a metaphysical level rather than at the physical level. Our analysis corroborates recent arguments to the effect that this interpretation is not ruled out so easily.

Key-words: Consciousness; interpretation of quantum mechanics; ontology; metaphysics.

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1 Introduction: why consciousness?

This volume deals with the relation between mind (or consciousness) and quantum mechanics (hereafter "QM"). Although some quite unrespectable claims are constantly made on behalf of such relation, it has undeniable pedigree: its sources are found on the earliest attempts to make sense of QM, when von Neumann [40] put forth an interpretation based on the concept of a causal consciousness—frequently labeled as "Consciousness causes collapse hypothesis" (hereafter "CCCH"). Remarkably, as recently shown by [9], up to this date the CCCH has survived empirical tests as much as any other interpretation of QM; moreover, its specific features (namely, the introduction of a causal consciousness) cannot be independently subjected to an empirical falsification,[1] thus surviving as a live option to interpreters of QM.

However, as shown by the poll presented by Schlosshauer (*et al*), [36], the CCCH is rather unpopular among the theorists working on the field of the foundations of QM. As an illustration, in a recent book, Lewis [27, §9] does not even consider the possibility of CCCH as a candidate for an interpretation of QM that could offer a reasonable worldview based on its commitments with dualism. It seems that having the label 'dualism' attached to it is enough for one to reject the CCCH. But what are the grounds for this rejection?

By rejecting CCCH because of its ties to dualism, what exactly are we rejecting? And for which reasons? The answer is not clear, it seems to us. The debates about mind and consciousness have always been problematic *per se*, and it should not be a surprise that when it comes to QM this issue only gets more complicated. In particular, difficulties arise from the fact that 'dualism' applies to a wide range of metaphysical options throughout the history of philosophy. As a result, even if it is clear that Neumann's CCCH falls within the metaphysics of dualism, it is still far from clear *which* form of dualism the CCCH is committed with (*e.g.*, the CCCH is dualist about substances or properties?).

In this paper we address precisely the issue of the nature of consciousness that is

[1] Nevertheless, it is not *unfalsifiable*, as the CCCH is *in principle* empirically distinguishable from any no-collapse approach to QM; see [15] for details.

involved in CCCH. Given that CCCH is immune to empirical testing, this metaphysical approach is useful for both friends and foes of CCCH, and we take it as a first step towards a more rigorous investigation into the metaphysical basis of CCCH. We begin by arguing that, unlike many other interpretations of QM, the CCCH *determines* in large measure its ontology and, to a lesser degree, the metaphysical profile of its posits. That happens precisely because the CCCH is *incompatible* with several metaphysical profiles available in the philosophical literature on consciousness; following French's Viking approach [21] to the metaphysics of science, we argue that if one considers the distinct approaches to dualism available in the philosophical literature, most of them just won't fit with CCCH. That puts the focus on some very specific approaches to dualism, making the theory and its ambitions clearer to evaluate. As a second step, given that dualism will be addressed metaphysically, we argue that there seems to be no good metaphysical reasons to rule out dualism *just because* it is dualist. To justify that claim, we will look at the metametaphysical literature to see whether dualism could be objectively ruled out in the face of other available metaphysical theories.

We structure the paper as follows. In the first section, we present the measurement problem and von Neumann's [40] solution to it. In the second section, we present a distinction between ontology and metaphysics that will enable us to somehow extract an ontological commitment and determine a metaphysical profile to it. Besides, the ontology that the theory gives us is incompatible with many versions of dualism. In the third section, we will look at the literature on metametaphysics to see how dualism survives some of the typical arguments addressed against it. In the fourth section, we stress that CCCH is compatible with some rather specific kinds of dualism, in such a way that not every approach to consciousness in QM qualifies as a CCCH approach—thus reducing considerably the scope of the discussion between mind, causality, and QM. We conclude in section five.

2 The "consciousness causes collapse hypothesis"

The CCCH, as many other interpretations of QM, is essentially a *response* to the measurement problem. As there is much discussion about this problem in the literature, we will employ Maudlin's [30] taxonomy, because it is a very concise way to put it. Moreover, we need only Maudlin's [30, §1] "problem of outcomes" to see what is at stake here. The measurement problem, then, can be seen as the inconsistency of three basic assumptions of the wave-function representation of quantum states $|\psi\rangle$:

1.A $|\psi\rangle$ is *complete*: it specifies all the physical properties of the system it represents;

1.B $|\psi\rangle$ evolves *linearly* though time: its dynamics is described by linear equations of motion (*e.g.* the Schrödinger equation);

1.C Measurements of $|\psi\rangle$ always have determinate outcomes (*e.g.*, either it is in one state or another, never in a superposition of states).

The proof of inconsistency of these three basic assumptions can be found in [30, pp. 7–8], so we will only comment it briefly. Suppose an experimentalist wants to measure the position of a quantum system S by means of a measurement apparatus A. According to 1.A and 1.B, the composite system $S+A$ evolves according to the Schrödinger equation. Then, by linearity, the states of $\hat{A}$ are also in superposition. This means that the possible A-states which correspond to, for example, different pointer positions, are superposed (hence, no definite single-state outcomes). But according to 1.C (and to our phenomenal perceptions in the laboratory and everyday life), we *do have* definite outcomes as a result of measurements. So, at least one of these assumptions must be dropped.

As we are interested in the CCCH approach, we are assuming implicitly von Neumann's [40] formulation of QM, within the so-called "collapse approaches" to QM—which denies assumption *1.B*. The idea of "measurement" as the outcome of the interaction between a quantum signal (S) and a macroscopic measurement device (A) is, nevertheless, an intuitive one. So, in order to preserve this intuitive reasoning, one may

suggest the attachment of a second measurement apparatus $\hat{A}'$ to measure the composite system $\hat{S} + \hat{A}$, in order to complete a measurement. We can reasonably consider it to be the experimentalist's eye, that observes the pointer reading. But as the second apparatus is related to the first apparatus in the same way that the first apparatus is related to the quantum object, linearity tells us that this is a new composite system $\hat{S} + \hat{A} + \hat{A}'$.

The problem remains in the sense that such interaction does not show a way out of the superposition describing the states of the composite system. In fact, this is the first step of an infinite regress, because one could suggest even that a *third* measurement apparatus is attached to the second apparatus, such as the optical nerve; and this optical nerve is related to a further measuring apparatus such as the brain, and so the argument goes *ad infinitum*.

This problematic situation is known as "von Neumann's chain". The main issue in von Neumann's measurement theory that we acknowledge here is that the linear descriptions of physical systems lead to an infinite regress: any attempt to reduce the superposition of the joint system with the introduction of further *physical* measuring apparatuses is doomed, since, as they are physical systems, they are to be described as a superposition as well. If the system is described by unitary dynamic laws, it will *always* be described by a superposition. As Baggott [7, p. 186] stressed, it is difficult to fault the logic behind CCCH's conclusion: if the measuring device is a physical system, then it should be described by the equations of motion of QM as well as quantum systems are; moreover, if macroscopic physical measuring devices are composed by quantum systems, then they should, at least in principle, behave similarly; therefore, the superposition of macroscopic measuring devices' states (*e.g.*, different pointer positions) is conceivable, and the interaction with the consciousness of the observer puts an end to the superposition's chain.

To von Neumann [40, pp. 418–420], the solution of this problem is to recognize that the "*act* of measurement" takes place in the (subjective) perception of the observer, because one's subjective perception is the most reliable source that superpositions are not experienced at all. This feature of von Neumann's [40, pp. 418–419] interpretation is known as the "principle of psychophysical parallelism" (see also Barrett, [8, §2.6]).

To explain it, von Neumann [40, p. 421] breaks down the measurement process into three stages: *I*, *II*, and *III*, where "*I*" is the quantum object, the system *S* being measured; "*II*" is the measurement apparatus (which could correspond to anything, from the instrument to the image registered in the observer's brain); "*III*" is *the observer*—more precisely, it is the observer's *abstract ego*.[2] The result of a measurement on *I* performed by $II + III$ is the same as the measurement on $I + II$ made by *III*. In the first case, the Schrödinger equation applies to *I*, and in the second case, it applies to $I + II$. That is, in all cases, the linearity of the Schrödinger equation does not apply to *III*, *i.e.*, *III* is the only part in which a measurement occurs: it is only with the interaction of the abstract ego that the chain of superpositions collapses.

This agent is described as something outside the ontological domain of physical systems. As Becker [11, p. 129] argues, the most relevant feature of the reasoning described above is that "physical processes must be explainable entirely in physical terms, but collapse, which is essential to the dual processes of quantum mechanics, cannot be explained entirely in physical terms". So the transition between a linear and a non-linear evolution is to be understood as a causal act of the observer's consciousness *upon* the composite system.

Note that this means that the agent that completes a measurement does not obey the same laws of the systems that are describable by quantum states. This is somewhat close to the view of complementarity, specifically as seen by Bohr [13], [14] (see also Faye, [19, pp. 128–129]) and Heisenberg [24] (see also Jammer [25, p. 98]). As it is well known, one of the efforts of Heisenberg was to determine the boundaries of the quantum-like domain, which is a central aspect of von Neumann's theory of measurement. This boundary is known as "Heisenberg's cut", which is placed in the measurement act.[3]

The discussion is usually about under which circumstances this "act" occurs. For both CCCH and complementarity, the circumstances for the measurement to occur

[2] Although the term "consciousness" is absent, it is almost unanimous that von Neumann [40, pp. 418–420] refers to the *consciousness* of the observer when he enunciates the causal feature of the "subjective perception" of the observer. For a historical motivation of this, see Jammer [25, p. 480].

[3] The German term "*Heisenbergscher Schnitt*" was coined by Pauli [31]; to a historical approach of it in the Copenhague spirit, see Landsman [26].

are placed *outside* the domain of QM, but their fundamental difference is *ontological* in the following sense. In the former, the measurement act ('*III*') is placed upon a *macroscopic* measurement apparatus (hence, a physical system), while von Neumann [40, p. 421] places it outside the domain of *physics*. And not just *quantum* physics, but *outside physics* itself. As von Neumann [40, p. 418] states, that the so-called intellectual inner life of the observer is "[...] extra-observational by its very nature". This suggests a "Cartesian cut", because the cut is placed in a different ontological level rather than within the same (physical) ontological domain of existence (see Atmanspacher, [5]).

There is another feature of CCCH that should be taken into account in this discussion: whose consciousness causes the collapse? This issue was first put forth by Wigner [41] in his "Wigner's friend" paradox, a thought-experiment in which an intermediate observer (the "friend") observes an experiment and then tells a final observer ("Wigner") about the observed result. In this case, one may consider the following solutions (accepting the debatable thesis that the macroscopic instrument enters into a superposition of pointer states):

- (W_1) The friend collapses the composite superposed state—apparently the solution of von Neumann. The second observer, "Wigner", should then describe the quantum system, apparatus and his friend as a collapsed state. This is the position adopted by Wigner [41, p. 177].

- (W_2) Not only the friend, but also "Wigner" enters into a superposition, and also any other observer in the chain. This is essentially Everett's [18] "relative-state" solution.

- (W_3) The friend also enters into a superposition, so "Wigner" is responsible for the collapse of apparatus + friend. This view can be encompassed within Rovelli's relational interpretation [34], in which the state of the world is relative to the observer. So, from the perspective of the friend, it is he who causes the collapse, while for Wigner it is Wigner himself who does so.

- (W_4) The last observer in the chain seems to have privileged status in provoking the overall collapse, while the others before him are in a superposed state all

along. This solution leads to solipsism, the theory in which there is only one causal consciousness and there is no consensus about to whom it belongs.

It should be clear that we are considering (W_1) only: we will not discuss (W_2) to keep this work self-contained, as it stands for a different formulation of QM (*i.e.*, no-collapse); (W_3) will not be discussed as well because it does not relate with the main subject of the paper, which is consciousness. We will engage briefly with (W_4), because it is a solution that is frequently adopted by authors that propose an integration between QM and spirituality *via* consciousness (see, for instance, [10] and [23]). As the solution (W_4) leads to solipsism, the authors *modify* the hypothesis according to which it is subjective consciousness that causes the collapse, but that there is only one god-like consciousness that causes it. The problem is that (W_4) seems to be a straw-man version of Wigner's friend, which by any means implies solipsism.

Another problem with (W_4) is the status of "cause". In order to avoid some possible misunderstandings about this (already controversial) subject, when we make a statement regarding the "causal power of consciousness", it is usually meant that consciousness causes the collapse (and hence, causes the measurement), and *not* that consciousness is the cause of physical phenomena (*e.g.*, (W_4)). In this sense, the notion of *causal power* of consciousness should be understood as the power of causing a change of state, from indeterminate to determinate (for a discussion about this last issue, see [37]). Nevertheless, it should be clear that the measurement apparatus, although not sufficient to bring the collapse about, is a necessary element in the measurement process in the very sense that consciousness is *unable* to directly perceive the state of the microscopic, quantum-mechanical system without an intermediate apparatus. This was pointed by de Barros [16, §3]: in order to measure some observable of a quantum system, we have to produce an experimental setup that amplifies the signals of the system of interest in a way that can be perceived by the observer; the experimental setup needs to be there in the sense that the state of the quantum system cannot be produced by consciousness alone.

3 Ontology and metaphysics

Here, we understand "ontology" as the study of *what there is*. Following the Quinean tradition, we assume that we can study scientific theories in order to extract the ontological commitments from those theories and discover *what there is* in the furniture of the world *modulo* such theories. That provides for a sort of *catalogue* of the beings the theory assumes as existing. That approach applied to CCCH allows us to claim that *consciousness* exists. Whatever it is in metaphysical terms, this entity—consciousness—is causally efficacious in the quantum measuring process. Consciousness is introduced in the furniture of the world by CCCH, with certain features (such as causal power).

We believe it is pacific that on what concerns CCCH's ontology consciousness exists. In the words of Ruetsche [35, §3.3], "[w]hat a realist believes when she believes a theory T is an *interpretation* of T, an account of what the worlds possible according to T are like"; so the interpretation would provide for the realist content of the theory. In the case of QM, as it is well known, pragmatists do not generally think QM needs an interpretation. A theorist inclined to accept the CCCH must embrace consciousness and the role ascribed to it by the interpretation. But this is just as far as the theory leads us, in philosophical terms. That is, the interpretation forces the positing of consciousness, but the theory alone gives us no means to understand *what is* such consciousness in metaphysical terms. That is a pressing issue. Is it a fundamental property of all beings? Is it an emergent property? Is it a separated property? QM is silent about it. One simply cannot extract a metaphysical profile from an ontological catalogue accounting for what there is. So, if we want to inquire about that, we enter the domain of metaphysics. Here, we label this effort to come up with a "metaphysical profile" of the entities posited in a theory's ontology.

The idea that a metaphysical profile is needed in order to completely specify the realistic content of a theory was called by French [21, p.48] *Chakravartty's challenge*. According to the challenge, it is not enough to point to some feature of a theory ('consciousness with causal powers' for instance) and say 'I am realist about that'. In order to have a legitimate realism about consciousness, one must clearly specify what it is, and doing so involves —at least partially—- providing for a metaphysical characterization

of consciousness. This links the ontology with the metaphysical profile. Also, providing for such profile may be enlightening, as we claimed in the introduction, if we are to know what the CCCH amounts to and to better ground any kind of attitude towards it we may happen to have (accept, reject, or whatever else).

As it happens, the metaphysical profile of the posits of scientific theories may be 'dressed metaphysically' in many incompatible ways, giving rise to a kind of metaphysical underdetermination. CCCH is much less liberal with the metaphysical profiles that may join the theory, as we shall see. In this sense, the ontology of a conscience with causal power requires a mind with very specific features. Let us see.

3.1 Dualism and metaphysics

Traditionally, CCCH's consciousness is understood within a *substance-dualist* metaphysical profile (see [1, p. 83], [38, p. 167], [39, pp. 58–59]). As we already mentioned above, in von Neumann's own solution to the measurement problem, the agent that causes the collapse is placed *beyond* the domain of application of QM, which concerns only the *physical* (in the sense of *material*) domain of reality. So, in this traditional viewpoint, consciousness acts upon the material domain causing the superposition of states to collapse into a non-superposed state; we find the quantum system in a definite state by virtue of such causal act of the observer's consciousness. This is a metaphysical statement about the nature and the behavior of this entity that was introduced in CCCH's catalogue of existing beings, and, in metaphysical terms, this is clearly a dualist claim.

But we should recognize that labeling CCCH "dualist" does not mean much if we are searching for the nature of the consciousness that is posited. There are many forms of dualism, and the CCCH is not compatible with every one of them. In this section, we will determine as much as possible the dualism(s) that may fit CCCH's ontology (so that one may address Chakravartty's challenge). On what follows, we will sketch some of the dualist taxonomy presented by [33, pp. 201–203]. This makes for a clearer case on what one is getting into by adhering to CCCH.

As one of its weakest formulations [32], we will define the basic dualism as *property*

dualism, the thesis holding that the *material* properties (*e.g.*, mass, charge, spin, and so on) and *mental* properties (*e.g.*, consciousness, intentionality, qualia, and so on) are not reducible in terms of each other; moreover, the material and the mental are fundamentally of different nature. This is dualism at its most basic characterization, and other types of dualism can be distinguished by how they modify this basic thesis.

1. *Substance dualism*: Material and mental properties are different substances, and the bearer of such substances are also of a different nature;

    (a) *Strong substance dualism*: The mental stuff is immaterial, and its properties are distinct and exist independently of the material stuff;

    (b) *Moderate substance dualism*: The mental stuff is immaterial, and its properties are distinct, but its existence depends on the material stuff;

As CCCH's ontology dictates, we will focus here on the *substance dualism*. Moreover, although the main difference lies in its strong and moderate versions, its taxonomy can be even further extended as:

1. *Pure dualism*: Material objects are defined by material properties only;
2. *Compound dualism*: Material objects are defined by material and mental properties;
3. *Non-spatial dualism*: Mental objects are defined by merely temporal properties;
4. *Spatial dualism*: Mental objects have spatial properties, hence, is extended through space;
5. *Theistic dualism*: Mental objects and properties are created by God;
6. *Naturalistic dualism*: Mental objects and properties are integrated with the material world;
7. *Interactionist dualism*: Material and mental objects maintain two-way causal relations;

8. *Epiphenomenalism*: Material stuff causes the mental stuff, but not the other way around;

9. *Pre-established harmony*: There are no causal relations between the material and the mental.

In this dualist spectrum, Cartesian dualism may be classified as a *strong theistic interactionist non-spatial pure dualism* [33, p. 203]. But what about CCCH? Which one(s) of the above metaphysical taxonomy of dualism should apply to its ontology? As it seems, there are many consciousness-based approaches to the measurement problem in QM; we will briefly review what are those options and how well they fare (or don't) within the constraints imposed by CCCH.

In the interpretation presented by London and Bauer ([29], the consciousness of the observer is treated by another Hilbert subspace $\mathcal{H}_C$ that interacts with those of the "objective" parts. Moreover, as French [20] has pointed out, in London and Bauer's [29] theory of quantum measurement, consciousness is not *causal* in the quantum-mechanical process of measurement, but merely *recognizes* a measurement result, as a way of attributing meaning to it in a phenomenological way. Moreover, London and Bauer [29] themselves recognize that their theory of measurement is to be understood within a phenomenological metaphysics (specifically a Husserlian approach), so it will not fit the consciousness *causes* collapse hypothesis. The *ontological* background is different from the one that we are investigating here. This issue deserves an investigation of its own, so we will not address the interpretation of London and Bauer [29] here.

Another consciousness-based approach to QM is the *many-minds interpretation*, put forth mainly by Lockwood [28], and it is easy to notice that it does not fit the causal aspect of consciousness of the CCCH: the main reason is that such approach is an extension of Everett's [18] relative-state approach to QM, in which there is no collapse (thus, no agent whatsoever *causing* the collapse).

As it seems, it is just von Neumann's [40] approach to QM that requires a consciousness with causal powers. So the basic ontological features of consciousness in CCCH are:

1. *Causality*: Consciousness must be a causal agent in the quantum measuring process;

2. *Transcendence*: The laws of QM that apply to *physical systems* should not apply to consciousness;

3. *Interaction*: There must be an interaction between physical systems and consciousness, as the latter modify the dynamics of the former.

These three main ontological features of CCCH's consciousness in fact show its incompatibility with several metaphysical profiles listed above. As it stands, the only metaphysical profiles that are compatible with CCCH's ontology are strong versions of naturalistic and interactionist dualism. All others are ruled out by some features of the ontology. Take epiphenomenalism, for instance: it does not admit mental causation, so it is unable to count as an interpretation of CCCH's consciousness. It's incompatible with what the theory gives as an *ontological output*. The same would go to any moderate version of dualism as well: if the very existence of a substance, say, mental, is *dependent* of the material, then consciousness would not be able to act as a causal agent in the measuring process of QM; and the other way around would not be compatible as well, because the mind *alone* could not create a result of a quantum measurement—its causal power is strictly dependent of the experimental setup in which the quantum system lies in.

In this sense, we are now in position to look for some very specific attempts at determining what consciousness could be (and what it *couldn't*) according to CCCH. Obviously, that does not solve the problem, but it leaves us in a clearer situation than the one we began with (even to formulate more clearly the difficulties with the view). Notice also that once CCCH is adopted (even if only as a working hypothesis), this counts as our version of quantum mechanics. From this perspective, it is the theory that rules some metaphysical versions of dualism out, providing for a kind of epistemic authority that the metaphysics alone would not have (see also Arenhart [2]).

4 On metametaphysics: can we rule out dualism on metaphysical grounds?

Even though we are able to classify with greater precision what CCCH's consciousness *could be* in metaphysical terms, dualism is still a very unpalatable idea for many. So perhaps it could be ruled out on other grounds, other than empirical? In this section we will address the the debate from a metametaphysical perspective, searching for some kind of evaluation of metaphysical theories to see whether there are good arguments to rule out at least some of the above forms of dualism compatible with CCCH.

4.1 Widen the net

If dualism could not be ruled out directly by physics [9], perhaps it could be ruled out if we expand our scope to other sciences which depend somehow on the results given by physical theories, such as neurosciences. This metametaphysical criterion was recently coined by Benovsky [12, pp. 82–84] as "widen the net": we should not look at isolated areas, but rather see how a metaphysical theory fits in a (more) general picture. In this sense, if dualism is compatible with physics, but incompatible with everything neuroscientists produced so far, the *widen the net* would be a good metametaphysical criterion to recommend that we abandon such metaphysical theory. However, this seems not the be case. As Arshavsky [4] shows, there would not be a single result in neuroscience that would be incompatible with dualism (at least so far); in fact, his study shows that much of the neuroscientists' vocabulary is essentially dualist. So this metametaphysical criterion would not do when one is looking for a way to discard dualism.

4.2 Causation

If dualism is the only metaphysical profile that one is able to plug with CCCH's ontology, it could be argued that although von Neumann's proposal solves the measurement problem, it also raises other philosophically puzzling problems concerning mind-body causation. In fact, causation is the ground from which the traditional challenges to du-

alism often occur. So, if our best theories about causation are incompatible with dualism, then it would pose a problem to the interpreter of QM adhering to CCCH. However, as [33, pp. 214–216] stressed out, the most popular theories about causation, such as counterfactual, covering law, probability raising, primitivist and energy flow theories of causation are all compatible with at least interactionistic versions of dualism—which the CCCH is also compatible with. So, still according to Rodrigues [33, p. 84], "[w]hatever truth about causation is, the best theories we have now don't rule out immaterial minds causing bodily changes".

4.2.1 Causal closure and naturalism

Let us take into account another objection that is commonly held against CCCH, which is the violation of the causal closure of the world. Roughly, the causal closure thesis asserts that every physical event must have a physical cause, and if it is true, it is violated by the attribution of causal power to a non-physical entity (see [6, p. 263]). The argument can thus be written as:

1. Everything happens according to the laws of physics;
2. There is no mental causality in the laws of physics;
$\therefore$ There is no mental causality in the world.

Notice that the second premise is based on *naturalism*, the thesis which holds that science is our best guide to metaphysics. If it is right (and that is debatable), then one may add CCCH with mental causality to the laws of QM, hence denying this very step. So, the causal closure cannot be used to rule out a metaphysical thesis implied by a physical theory.

4.3 Uninformativeness

Another common ground of criticisms against dualism is uninformativeness [33, pp. 203–207]: it is often objected that dualism does not adequately characterizes, in metaphysical terms, what the mind-stuff *is*. As pointed out by de Barros [16, §2], it seems that

von Neumann's solution replaces "[...] a mystery by another mystery, without adding any explanatory power". It does not explain consciousness in terms of what it *is*, but in terms of what it *does*. In this sense, the CCCH is uninformative and hence should lose its attractiveness to interpreters of QM.

To resist this objection, one might look at *opposite* metaphysical views. Take materialism, for example. Does it answers what matter *is*? Its answer is as functional as the dualist's. In QM, other approaches to the measurement problem fail to explain what the mechanisms of measurement *are*: what are parallel universes [17]? Or what is the mechanism responsible to physical collapses [22]? The answer, again, is functional. CCCH is not worst off than the alternatives.

As pointed out by Rodrigues [33, p. 222], dualism raises more questions than answers. But so does QM when relating to the measurement problem. So, there seems to be no definitive objections to CCCH and its dualist metaphysics.

5 Conclusion

Dualism suffers from a curious fate. While it seems a rather natural step in explaining conscious phenomena, and won't go away by any empirical means, it is widely regarded as way too exoteric in order to account for quantum collapse. In fact, there are rarely arguments against it; it is just taken by many to be a non-starter. To make matters worse, dualistic understandings of quantum mechanics are responsible for most of the pseudo-scientific literature on quantum mechanics, making it difficult sometimes to provide a sensible account of the view without prejudices.

We have attempted to provide a clearing of the ground for further serious work on the relation of mind and quantum mechanics on the specific interpretation first presented by von Neumann (the CCCH). Carefully articulating the view requires that the role of consciousness in QM is seen as a causal factor responsible for the collapse. In this sense, the ontology associated with CCCH requires a conscience with causal powers over matter, and that matter and mind be clearly distinguished. This, on its turn, provides for both a precisification on the kind of approach to consciousness that

is compatible with CCCH as well as for a restriction on the scope of the metaphysical theories available to do the job. That illustrates a collaborative work between science and metaphysics, with science providing for a test ground for metaphysical theories.

Furthermore, we have argued that, given that metaphysics will play a major role in dressing the posited consciousness with some important features, purely metaphysical arguments are also —at least so far— unable to rule CCCH as implausible. Given that, it could be the case that CCCH could be much better understood if current forms of dualism compatible with it could be ore clearly articulated together, so that existing metaphysical theories could be employed to somehow enlighten the role of consciousness in CCCH. This is a demanding task, we leave it for a future work.

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