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Spacetime Emergence in Quantum Gravity: Functionalism and the Hard Problem

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forthcoming in *Synthese*

Abstract

Spacetime functionalism is the view that spacetime is a functional structure implemented by a more fundamental ontology. Lam and Wüthrich have recently argued that spacetime functionalism helps to solve the epistemological problem of empirical coherence in quantum gravity and suggested that it also (dis)solves the hard problem of spacetime, namely the problem of offering a picture consistent with the emergence of spacetime from a non-spatio-temporal structure. First, I will deny that spacetime functionalism solves the hard problem by showing that it comes in various species, each entailing a different attitude towards, or answer to, the hard problem. Second, I will argue that the existence of an explanatory gap, which grounds the hard problem, has not been correctly taken into account in the literature.

Contents

1 Introduction

Several approaches in physics entail that space (or spacetime) emerges from a structure in which interesting features of space and time are missing. This is the case in many approaches to quantum gravity: for instance in loop quantum gravity and string theory[1], but also in a particular approach to quantum mechanics: configuration space realism.[2] A general issue is then to understand the nature of this relation of emergence and to determine what sort of ontological picture follows from spacetime emergence. Lam and Wüthrich (2018) have suggested—in the context of quantum gravity—to identify this relation of emergence[3] with a *relation of functional realisation*—thereby drawing inspiration from the philosophy of mind where functional realisation[4] is a popular way to analyse the relation obtaining between physical states and mental states.[5]

In this paper, I examine how exactly functional realisation may help us understand situations of spacetime emergence. More precisely, I examine whether the view that spacetime is a collection of functional roles may help (dis)solve several problems associated with spacetime emergence. Indeed, although Lam and Wüthrich (2018) focus on a particular epistemological issue that I will discuss later—namely, the *problem of empirical coherence* (introduced by Huggett and Wüthrich, 2013): How are we going to justify a theory which threatens its own

[1]For a review, see e.g. Huggett and Wüthrich (2013), Crowther (2016) and Le Bihan and Linnemann (2019).

[2]See e.g. Monton (2002, 2006), Maudlin (2007) and Ney and Albert (2013).

[3]Note that the expression "emergence", in this context, should be understood as a neutral expression, a *placeholder* for a problem, which does not entail any particular interpretation of the nature of the relation. This point deserves our attention since the term has a different meaning in philosophy and general philosophy of science on the one hand, and in philosophy of physics and physics on the other hand—the separation may be drawn differently, but what matters here is that there exists two different terminological traditions. In the field of general philosophy, the relation of emergence is a very specific notion associated with highly specific features: emergent entities are regarded as not owned by the system from which they emerge, being both novel in some sense, and ontologically dependent upon the entities they are emerging from, thereby going against reductionism. In contrast, in physics and philosophy of physics proper, the relation is generally regarded as a generic one that still has to be interpreted further and is even consistent with reductionism (see Butterfield, 2011 and Crowther, 2018).

[4]Spacetime functionalism also designates an approach defended by Knox (2013, 2014, 2017) according to which the concept of spacetime *within a physical theory*, and in particular general relativity, should be analysed as a particular functional role in the theory. I will not say anything about this view and how it relates to Lam's and Wüthrich's account.

[5]Other candidate relations for this spacetime "emergence" are philosophical emergence, brute constitution, grounding and mereological composition (see Le Bihan 2018b).

evidence which, arguably, is located in space and time?—they take their functionalist strategy to have a broader application, when they write:

> We will investigate to what extent a functionalist perspective allows us to *bridge the metaphysical gap* between the structures postulated by these theories and smooth classical spacetime as we find it in GR. (Lam and Wüthrich, 2018, p.40, my emphasis)

To put it differently, according to Lam and Wüthrich (LW from now on) functionalism might, in principle, do more than just solve the problem of empirical coherence by also providing an answer to the more general philosophical issue of accounting for the "metaphysical gap" obtaining between a spatio-temporal theory (General Relativity, GR for short) and a non-spatio-temporal theory—a problem that amounts, in the context of Quantum Gravity, to asking, first, whether *GR spacetime does (not fundamentally) exist or, on the contrary, does not exist* and, second, about how we may connect a more fundamental non-spatio-temporal structure with a less fundamental spatio-temporal structure. However, they also write:

> Whether one ultimately wishes to be a realist or an eliminativist about spacetime is orthogonal to our concern here. (Lam and Wüthrich, 2018, p.40)

and,

> [F]rom a functionalist point of view, nothing remains beyond showing how the fundamental degrees of freedom can collectively behave such that they appear spatiotemporal at macroscopic scales in all relevant and empirically testable ways. This turns out to be a hard task in quantum gravity. *Functionalism can be seen as the assertion that once this task is completed, no unfinished business lingers on.* (Lam and Wüthrich, 2018, p.44, my emphasis)

There is a tension in the conjunction of these three quotes—one which may be addressed in various ways. Indeed, those assertions may be read as contradictory answers to the question suggested by the first quote: Is functionalism able to bridge the metaphysical gap (a question that I will call the "hard problem of spacetime emergence" for reasons that I will explain later)? The second quote suggests that it *cannot* do so since spacetime functionalism is *orthogonal to the hard problem*. The third quote suggests a *positive answer* to the question, at least if we take the dissolution of an issue to count as a particular

solution to this issue: Functionalism is the last word regarding spacetime emergence, and solves everything there is to solve. There would be nothing left to explain and, as a result, there would not be any hard problem. In other words, we observe a shift from the claim that *functionalism is orthogonal to the hard problem of spacetime* (claim 1. from now on) to the claim that *functionalism (dis)solves the hard problem of spacetime* (claim 2. hereafter).

However, and despite the tension between the three quotes, I share some of the intuitions that I take to lie behind the formulation of those two claims; and I believe that some claims in the vicinity of 1. and 2. are correct. As a result, I will defend the three following—similar but distinct—claims:

- 1*. functionalism may be regarded as a view orthogonal to the hard problem of spacetime *when subscribing to a particular sort of functionalism*,
- 2*. functionalism may be regarded as a particular solution to the hard problem of spacetime *when subscribing to a particular sort of functionalism* and,
- 2**. functionalism helps to solve some—but not all—problems of spacetime emergence.

It should be clear at this point that the paper is not an attack or a defense of LW's paper but rather a clarification of what functionalism can do for us when we face the most metaphysical issues arising in scenarios of spacetime emergence. In section 2., I begin by introducing two possible cases of spacetime emergence—in *string theory* and *loop quantum gravity* (section 2.1). I then offer a novel classification of philosophical issues that may be raised when faced with the claim that spacetime does not exist fundamentally by distinguishing four distinct issues: the scientific problem, the problem of empirical coherence, the ontological problem and the hard problem of spacetime (sections 2.2 and 2.3). In section 2.4, I discuss whether there actually is a hard problem of spacetime by focusing on the concept of spacetime *qualia* and argue that the concept has been dismissed too quickly in the literature. Arguably, strictly speaking there are no spacetime *qualia* since there is no *phenomenal* what it is like to be spacetime. However, there is a *physical* what it is like to be spacetime, which is embedded through the relational structure of spacetime as (at least minimally) described by General Relativity, that is regarded as being missing in quantum gravity, thereby justifying drawing a comparison between the difficulty of relating *qualia* with physical facts on the one hand, and the difficulty to account for the transition from a non-spatio-temporal

structure to GR spacetime on the other hand. I then turn to functionalism in the philosophy of mind, distinguishing between four kinds of functionalism about the mind, each relying on a different answer to the hard problem of consciousness (section 3.1). In section 3.2, I show that this classification applies similarly to spacetime emergence and that it is also convenient in this context to distinguish between four sorts of spacetime functionalism.[6] Finally, I close by showing that some kinds of spacetime functionalism solve—but are not orthogonal to—the hard problem of spacetime whereas another kind of spacetime functionalism is orthogonal to—but does not solve—the hard problem.

2 Spacetime Emergence

2.1 Two Examples of Spacetime Emergence

Spacetime is regarded as potentially emerging from, or being constituted by, a non-spatio-temporal structure in various approaches to QG, to various degrees. At first glance, it may mean several things depending on whether *space*, *time* or *spacetime*, comes under attack. As Le Bihan and Linnemann (2019) argue, if one defines the existence of a minimal spacetime as the existence of a local split between two structures—"space" or "quasi-space" on the one hand, and "time" or "quasi-time" on the other hand—then we find such a distinction implemented in most approaches to quantum gravity, either with Lorentz symmetries or through another diachronic principle. However, and as suggested by the expression "quasi-space" and "quasi-time", this is not to say that no interesting features usually ascribed to space and time are missing in quantum gravity. Let us have a look at the most popular approaches to quantum gravity in order to get a sense of such a disappearance: *string theory* and *loop quantum gravity*.[7]

In string theory, the 4D spacetime emerges, *prima facie*, from a 10D structure. According to a naive understanding there is no problem of spacetime emergence in this context since the additional dimensions are compactified: it is simply that we just fail to notice them when we zoom out. But there are five different dual 10D string theories, and models of these theories are empirically equivalent. Some of those

[6] Yates (forthcoming) already made interesting distinctions between various sorts of spacetime functionalisms. However, I will not use his classification since it is not primarily designed to address the hard problem of spacetime. Rather, I will start with the classification of functionalisms about the mind that I find the most promising to address the hard problem and, then only, I will apply it to spacetime functionalism.

[7] For a more general review, cf. Huggett and Wüthrich (2013) and Le Bihan and Linnemann (2019).

models are related by T-duality and possess different compactification radius. As a result, the network of dual theories has to be related to a more fundamental M-theory, which still has to be found, *and* to GR. Therefore, the classic story about the compactification of unobserved dimensions does not explain away the emergence of GR spacetime. And importantly for our purpose, as demonstrated by Huggett (2017) the target spaces on which the strings live cannot be identified with GR spacetime. What, then, is the many-to-one relation between dual theories and GR spacetime?

A lively discussion is still on about how we should interpret duality, in particular in the context of string theory.[8] I will not get into the details of this discussion but merely note that if we remain at the level of the many-to-one relation obtaining between target spaces and GR spacetime, we have a problem of spacetime emergence. And, if we subscribe further to a particular philosophical (and popular) interpretation of this many-to-one scheme, namely the *common core approach*, then what is real is the common core of the dual theories. Since these duals do not share much structure (they can vary in mereological structure, dimensional compactification radius), this common core structure, or "quasi-space", if borne out, would have to substantially differ from space.[9]

In loop quantum gravity (LQG hereafter), what there is instead of spacetime are entities (or a structure) *described by* "spin networks" or "'spinfoam"—namely, collections of nodes and relations (the loops) between these nodes (see Rovelli 2004 and Rovelli and Vidotto 2014; for a summary aimed at philosophers cf. Huggett and Wüthrich 2013, 279-280). Spin foams describe discretely valued volumes and areas leading to a question about the nature of the relation obtaining between these discrete structures and the continuous GR structure. Importantly for our purpose, the organisation of the LQG structure may not correspond systematically to the spatio-temporal ordering of events, as described by GR: indeed, in some models of LQG, some *relations of adjacency* in the LQG structure correspond to *relations of large spatio-temporal distances* in the GR structure. See e.g. Markopoulou

[8]See e.g. Rickles (2011, 2013, 2017); Teh (2013); Matsubara (2013); Read and Møller-Nielsen (2018); Le Bihan and Read (2018); Weatherall (2019) and Butterfield (forthcoming).

[9]Other philosophical interpretations of duality might avoid saying goodbye to spacetime, for instance by adopting the nihilist view that none of the dual theories offer accurate enough descriptions of the world—thereby entailing that duality has no metaphysical significance (see Le Bihan and Read 2018). This is not the place to examine the consequence of each philosophical interpretation of duality on the problem of spacetime emergence. What matters for my purpose is that at least some, *prima facie* plausible, interpretations of duality entail that space is missing.

and Smolin (2007) and Huggett and Wüthrich (2013, 279-280) for a philosophical discussion.

When we face such scenarios of spacetime emergence, we may distinguish between at least four distinct issues. Let us start with the most famous problem of spacetime emergence in the philosophical literature: namely, the problem of empirical coherence.

2.2 The Problem of Empirical Coherence

Problems of empirical coherence arise when a scientific theory puts at risk the very existence of its empirical evidence. Problems of this sort have been said to arise in various contexts. It has been discussed by Barrett (who introduced the term) in the context of quantum mechanics[10] and then in the context of a specific interpretation of quantum mechanics (*configuration space realism* or *wave function realism*).[11] But, within the scope of this essay, we only need to concern ourselves with a particular version of the issue presented later on by Huggett and Wüthrich (2013) in the context of quantum gravity. Assuming that spacetime emerges from a non-spatio-temporal structure, how are we going to make sense of the possibility of making measurements somewhere and somewhen? Can we rely on measurements occurring in space and time to justify the claim that space and time do not exist?

Several things can be said in response to this point. For instance, one may argue that spacetime does not need to be *fundamentally real* but only *derivatively real* in order to account for the empirical coherence of any theory denying the fundamental existence of spacetime (Wüthrich, 2017, 298). Or, alternatively, one might point out that the physicality of the physical world flows down in a straightforward way from the mathematical derivation of the derivative theory—a theory that can be safely related to the empirical realm. At this stage, one may already wonder whether we really need the *fundamental existence* of rods and clocks or of any other experimental device, or whether the *derivative existence* of these devices is all we need to rule out issues of empirical coherence. Indeed, perhaps we only need experimental devices, namely chunks of reality that appear, in practice,[12] as entities located in space and time. We here have a first glimpse of another—more metaphysical—problem, *the ontological problem*: what is the

[10] Barrett (1996).

[11] See e.g. Monton (2002, 2006), Maudlin (2007) and Albert (2015).

[12] It is tempting to use the word "effective" in this context. However, the term is ambiguous in that it is sometimes associated in the literature with a particular domain of energy, and sometimes with the concept of approximation.

ontological status of spacetime?[13] This issue relates closely to the problem of empirical coherence; however, as we shall see, it should not be identified with it.

But before turning to the ontological problem, a final word about the problem of empirical coherence is in order. As acknowledged by Christian Wüthrich (private discussions), the problem of empirical coherence for quantum theories of gravity was mounted by Nick Huggett and Christian Wüthrich, who were opened to the idea that spacetime might not exist, fundamentally, in order to make sense of, and argue against, the claim made by other more skeptic philosophers that the view does not even make sense. Unfortunately, the problem of empirical coherence only achieved partially this goal, as we shall see, since it does not answer to *all* of the intuitions detractors of emerging spacetime rely on.

2.3 Easy and Hard Problems

The comparison between the problem of spacetime emergence in the philosophy of quantum gravity and the hard problem of consciousness in the philosophy of mind has been introduced by Le Bihan (2018a,b) and Le Bihan and Linnemann (2019). Let us have a look at the situation in the philosophy of mind in order to lay the ground for a discussion of spacetime emergence. One may describe the field of the philosophy of mind as focusing primarily on offering a convincing story about the relation obtaining between mental and physical entities, being granted that mental entities seem, *prima facie*, to display at least two specific sorts of features—*two marks of the mental*—at odds with features of the physical world. A first mark of the mental is *intentionality*: some mental states, perhaps all of them, are directed towards an object, that may or not correspond to a physical entity.

A second mark of the mental is the presence of *qualitative features*: mental states have a "what it is like to experience this particular state", namely *qualia*. Experiential states, in particular, display those qualitative aspects. Any attempt at naturalising the mind—namely at explaining these apparent distinct features in the background of a physicalist ontology—must take care of these two aspects. The existence of these two aspects does not necessarily mean that there are two sorts of mental states, namely states associated with propositional attitudes that would exhibit intentionality on the one hand, and experiential states associated to qualitative aspects; it might be

[13]Note that this expression might also be used to refer to another related problem, namely the problem of understanding the ontological status of non-spatio-temporal entities (see Lam and Wüthrich 2018).

that propositional states are associated with qualitative features, and experiential states with an intentional component (cf. Horgan and Tienson, 2002). What matters here is that philosophers of mind must meet two distinct challenges: naturalising intentionality and naturalising *qualia*. The problem of intentionality, in particular, has prompted philosophers of mind to ground the intentionality of the mind in "physical functions", for instance in biological functions as with the teleosemantic approach (cf. Macdonald and Papineau, 2006), or in states of physical systems similar to computers with the computational theory of thought (see e.g. Rey, 1997). Therefore, functionalism turned out to be handy for dealing with the task of naturalising intentionality.[14]

When it comes to the naturalisation of *qualia*, functionalism is not that helpful though: *qualia* seem to resist any functional treatment since their very essence is to exhibit a qualitative feature that resists to any reduction to features of a physical system. As a result, Chalmers (1995) distinguished between the hard problem of consciousness—which amounts to explaining the phenomenological specificity of *qualia* in a physicalist ontology or, to put it differently, to deal with the apparent impossibility to naturalise *qualia* because of the explanatory gap between the mental and the physical (see Levine 1983)—and other "easy" issues such as the scientific problem and the problem of intentionality. Those issues are easy in the sense that they seem tractable and tightly related to empirical issues.

Following Le Bihan (2018a,b) and Le Bihan and Linnemann (2019), one may apply this distinction between easy problems and a hard problem to the context of spacetime emergence. In fact, it is useful to distinguish between four distinct issues: the *problem of empirical coherence* that I have introduced in the previous sub-section and three other issues, the *scientific problem*, the *hard problem*, the *ontological problem*.

First, we must actually derive General Relativity from Quantum Gravity—using mathematical tools and bridge principles between the primitive notions of the two theories. Let us call this: "the *scientific problem*". It is the analogue of another scientific problem in the context of the philosophy of mind, namely the finding of systematic correlations between physical states and mental states.[15] The scien-

[14]Mental states are sometimes said to have a third defining feature in being owned by a particular entity, namely a self. The problem of subjectivity is more specific since not everyone agrees that there actually is a sense of the self, a qualitative self with a phenomenological specificity similar to *qualia*, that should be explained. See for instance Benovsky (2018).

[15]This is not to say that the two scientific problems are identical. In the context of quantum gravity, the problem is to find a derivation of one theory from the other; in the

tific problem is an easy problem in the sense that it may be achieved in principle in such a way that, as soon as it will be done, nothing will be left to achieve. Of course, this denomination should not fool ourselves: this issue is one of the most difficult problems ever met by theoretical physicists since it requires formulating a theory of quantum gravity and relating it to GR.

Second, the *hard problem of spacetime* is very similar to the hard problem of consciousness. The hard problem of spacetime is to account for the apparent explanatory gap, or conceptual discrepancy, between the primitive notions of the spatio-temporal and the non-spatio-temporal theories. Indeed, the cognitive dissonance is defeasible evidence for the existence of an explanatory gap—and so, conclusive evidence that there is a concrete issue to be addressed here, just as with the analogous case in the philosophy of mind. We will see above a potential example of an explanatory gap with disordered locality in loop quantum gravity, as the specifics of the explanatory gap will vary from one approach to quantum gravity to another.

Third, it relates closely to the *ontological problem*—namely, understanding whether spacetime is real or not—since particular answers to the ontological problem lead to various answers to the hard problem. For instance, eliminativism about spacetime, the view that spacetime does not exist—one answer to the ontological problem—deflates the hard problem of spacetime ontologically speaking, but not the hard problem broadly conceived since the eliminativist still has to provide an explanation for the success of GR, and for our phenomenology of a world in which things obtain in space and time (after all, space and time seem to exist *at least* at the macroscopic scale). Realism about spacetime—another answer to the ontological problem—entails a different approach to the hard problem of spacetime differently, by enquiring about the relation obtaining between the more fundamental non-spatio-temporal structure described by QG and the less fundamental spatio-temporal structure of GR—two real structures. Therefore, although one may formally distinguish between the hard problem and the ontological problem, the two issues are deeply entrenched.

Let us already note that one might argue that, independently of whether there is a hard problem of consciousness, there is no hard problem of spacetime emergence. We will examine this claim in the next sub-section; what matters at this stage is that there is *prima facie* an issue that needs to be addressed, even if its solution amounts to claiming that there is no equivalent of the hard problem of consciousness in the case of spacetime emergence. Indeed, as a matter of fact, the claim that spacetime emerges from a non-spatio-temporal struc-

context of the philosophy of mind, the aim is to map mental states upon physical states.

ture has triggered skeptic reactions: spacetime must be fundamentally real, it has been claimed, otherwise we would end up with a gap between the world as we experience it and theorize it through GR on the one hand and its fundamental structure on the other hand. Something has to be said in response to those reactions, if only to explain why they are not accurate or why and how they could be dismissed.

Finally, let us ask whether the problem of empirical coherence should be regarded as an easy or hard problem. Unlike the easy and hard problems of spacetime emergence, the problem of empirical coherence does not arise from looking at the relation obtaining between two theories, but between a fundamental non-spatio-temporal theory—or what is taken to be the most fundamental theory[16]—and empirical evidence located in space and time. However, let us set aside the fact that the problem of empirical coherence deals with the relation between a theory and its evidence rather than with the relation obtaining between two theories. As far as I can see, *the best analogue of the problem of empirical coherence in the philosophy of quantum gravity is the problem of intentionality in the philosophy of mind.* Indeed, first it is not entirely clear *prima facie* whether the problem of empirical coherence is easy or hard, just like the problem of intentionality is not systematically categorised as being easy or hard. Second, after closer examination, the problem of empirical coherence, when we carefully distinguish it from the hard problem of spacetime emergence, does not seem that difficult. The situation echoes what became to be a standard view in the philosophy of mind: the naturalising of intentional states is not that problematic as soon as we distinguish clearly between the qualitative feature and the intentional feature of mental states. Intentionality may be explained functionally without taking position on how we should deal with *qualia*. Likewise in the philosophy of quantum gravity, the problem of empirical coherence can be given a functional treatment without subscribing to a particular view on the reality of spacetime, or on the nature of the relationship spacetime holds with the QG structure that implements it (as we shall see in section 3, the obvious candidate from a functionalist perspective—the relation of functional realisation—is ambiguous as it may refer to a purely linguistic entity, or to a more ontologically-loaded relation).

In brief, the construction of a problem of empirical coherence was an important milestone in the general project of turning intuitions against spacetime emergence into actual problems. But even if the scientific problem and the problem of empirical coherence were to be solved, we would still want to know about the ontological status of spacetime (does it exist or not?) and how it relates with the more

[16]It might be that the quantum theory of gravity is not fundamental.

basal structure that implements it (what is this relation, can we make sense of the conceptual dissonance arising from the comparing of the two structures?). And if one wants to deny that there is an ontological problem, along instrumentalist lines, one must at least explain what is wrong with the hard problem, and the intuitions of some scholars[17] that there is too much of a gap between the spatio-temporal and the non-spatio-temporal, in such a way that the very notion of spacetime emergence, according to them, is inconsistent. Therefore, the ontological problem and the hard problem constitute another challenge that should be met by friends of spacetime emergence. This challenge has been neglected since philosophers have believed that the concept of spacetime *qualia* does not make much sense, preventing them to actually engage with the hard problem. However, as we will see, although the notion of "spacetime *qualia*" is certainly more dubious than the notion of *qualia* in the philosophy of mind, there genuinely is a cognitive dissonance between the spatio-temporal and the non-spatio-temporal notions that must be addressed.

2.4 Addressing the Cognitive Dissonance

The very existence of a hard problem of spacetime relies on the idea that one experiences a cognitive dissonance when considering a spatio-temporal theory and a non-spatio-temporal theory, similar to the one experienced when comparing the physical and the mental—a conceptual gap which triggers a need for explanation. The general agreement among philosophers of physics seems to be that there is no equivalent to the concept of *qualia* in the context of spacetime emergence and so, that there is no important conceptual gap that should be taken care of in the case of spacetime emergence. This is for instance the view advocated by LW who follow Knox (2014) on this matter:

> It is not clear [...] how much traction the "*qualia*" concern really gets in the spacetime case as compared to the philosophy of mind. As Knox (2014) puts it, "[w]here the fan of *qualia* has introspection, the fan of the [spacetime] container has only metaphor" (16). The nature and status of the evidence in favour of *qualia* may be equivocal, but the alleged ineliminable intrinsically spatiotemporal but ineffable quality of a spacetime substance remains positively elusive. What could remain of that quality once we have accounted for all relevant spatiotemporal features such as

[17] For a discussion of this kind of worry in the context of canonical quantum gravity, see Lam and Esfeld (2013).

> (relative) localisation as captured by the relative spatial and temporal order, their metric valuations in spatial distances and temporal durations, and perhaps more? (Lam and Wüthrich 2018, section 3)

First, I would like to note that LW do not dispute a problematic simplification made by Knox (2014) in this quote in associating the container metaphor with realism about spacetime (conditioning the existence of spacetime *qualia* to the existence of substantial spacetime). Strictly speaking, the container metaphor should only be associated with one version of realism, namely *substantivalism about spacetime*, the view that spacetime is a substance in which things take place.[18] But note that spacetime relationism, the view that spacetime is a network of relations, denies the relevance of this container metaphor.[19] Then, it is a further and distinct question whether such a relationist view of spacetime should be categorised as a realist or an anti-realist view about spacetime. In other words, one might be realist about spacetime along a relationalist/structuralist approach (see e.g. Bain, 2006, Esfeld and Lam, 2008, Le Bihan, 2016). The question of whether relationism should be best thought of as a form of realism or of anti-realism about spacetime might be regarded, at first glance, as a purely terminological matter, at least to some extent. However, when we look at radical cases of spacetime being missing in quantum gravity, it becomes clear that the non-fundamental existence of spacetime does not amount to claiming that spacetime is nothing else than spatio-temporal relations. Indeed, think for instance about *disordered locality* in loop quantum gravity (Markopoulou and Smolin, 2007) that I mentioned before: if borne out, such a view would entail that GR spacetime, even if correctly described as a network of relations, does not exist fundamentally because the fundamental network of relations has a *different structure*. The problem with spacetime emergence is that even an ontologically light spacetime—as described by relationism and/or structuralism—might emerge from a non-spatio-temporal *distinct* structure. What matters here is not to which ontological category belong the two structures (relations, substances or something else) but the fact that we have to deal with *two* structures.

Consequently, it should be clear that in the context of spacetime emergence, one must distinguish carefully between spacetime relationism and spacetime eliminativism—two views that reject the container metaphor. As a result, the container metaphor should not be as-

[18] See e.g. Pooley (2013) for a presentation of those approaches.

[19] The relationist/substantivalist opposition relies on several differences, the relevance of the container metaphor is just one of them, see e.g. Le Bihan (2016).

sociated with spacetime realism, but only with a particular sort of spacetime realism, namely spacetime substantivalism. This point is important as it shows that spacetime realism is not necessarily tied with the container metaphor mentioned by Knox (2014), and that someone arguing that there is something strange in the transition from the non-spatio-temporal to the spatio-temporal does not have, as a matter of necessity, to be motivated by the container metaphor. This is simply not what is at stake with the existence of an explanatory gap between GR and QG, or with the possible existence of spacetime *qualia*. For instance, in the particular case of disordered locality, the notion of spacetime *qualia* that should be discussed has nothing to do with the existence of a substantial spacetime or a container; if there is anything like a spacetime *quale* that seems to be missing in this example, this is the partial ordering of events—a potential "what it is like to be spacetime" which must be related somehow to the fundamental structure with distinct disordered locality. To repeat, what is at stake is the puzzlement about how to link the spatio-temporal with the non-spatio-temporal, being granted that the spatio-temporal does not have to be linked to a container metaphor, but only with existence of a particular ordering structure. And, one step further, arguing that spacetime *qualia* do not make sense—say, because they rely on a muddy metaphor—is not enough to silence the deep intuition that there is something left to explain, a conceptual discrepancy, which motivates some scholars to refuse to consider seriously the hypothesis that spacetime might emerge, somehow, from a non spatio-temporal structure.

In brief, the container metaphor is a bad candidate for grounding the existence of spacetime *qualia*. If they exist, those spacetime *qualia* are more likely to be identified with a specific structure (say the metric field in GR, or the ordering of events observed through experience).

Therefore, in what follows, I will assume that there is *prima facie* a hard problem of spacetime emergence grounded in the cognitive dissonance between spatio-temporal and non-spatio-temporal notions. The expression "*prima facie*" is here important since it leaves open that, after careful examination, there is no hard problem of spacetime emergence in the sense that the apparent cognitive discrepancy may be cured by some theoretical machinery explaining why this experience is deceiving. I suspect that this is the view that LW share. As a result, LW and others might claim that all of this discussion is an unnecessary detour, when one should simply point out that there is no hard problem and that one should stop worrying about it.

However, and although I am sympathetic to this possible reaction to the hard problem, I believe it is missing the overall dialectical con-

text in which this discussion takes place. Indeed, from my point of view, Knox, Lam and Wüthrich under-estimates the *dialectical importance* of the cognitive dissonance when it comes to the reticence of some scholars to seriously consider that spacetime might not exist fundamentally. Although LW are right to point out that spacetime *qualia* would have to differ greatly from the *qualia* to be found in the philosophy of mind literature, and that those spacetime *qualia* would have to be "more elusive" than *qualia*, it does not follow from this that there is no experience of conceptual discrepancy that explains why so many scholars take as an *a priori* and necessary constraint that the world must be fundamentally spatio-temporal. Now, this is a genuine and a difficult question whether the conceptual discrepancy associated with spacetime emergence should be explained by the existence of spacetime *qualia*, understood as a defining feature of the spatio-temporal structure that would prevent it to be simply reduced to features of a non-spatio-temporal structure.

Furthermore, one might argue that the analogy between the two cases at hands (consciousness and spacetime emergence) breaks down because facts about *qualia* cannot, as a matter of principle, be deduced from physical facts, when it should be possible to derive GR from QG.[20] As a result, the two cases of consciousness and spacetime emergence would be disanalogous to some degree. However, as a response, note the ambiguity in the claim of derivability of GR from QG. What it means is that in the quantum gravity context, the aim is to obtain GR as a mathematical approximation of QG. However, obtaining GR as a mathematical approximation is not enough to relate *facts* about the primitive concepts of the two theories, as it would simply relate structural aspects of the two theories (see Le Bihan and Linnemann 2019). Imagine that we can derive all of the "behaviour" of matter and energy as described by GR, at relevant scales, from a theory of QG. This behaviour corresponds to the structural facts about spacetime according to GR. But now we must explain how some GR structural facts or some GR non-structural facts relate to the theory of QG. For instance, if we take again the example of disordered locality, explaining the appearance of GR locality (a structural fact) from this QG distinct structure along statistical procedures will leave open whether the what is it like to be GR spacetime (its locality structure) is genuinely explained away by facts about the disordered fundamental structure. This is not to say that the hard problem of spacetime cannot be dissolved, but it means that at a superficial level the analogy holds. And we only need the superficial level for the analogy to hold, and in order to justify considering seriously the hard problem of space-

[20]I thank an anonymous reviewer for raising this point.

time emergence. Then only, it is a distinct question whether the hard problem of spacetime emergence should be answered, or dissolved.[21]

In order to show that from the difference of profile between spacetime emergence and the mind-body problem, it does not follow that there is no relevant explanatory gap to be addressed—and therefore no hard problem of spacetime—I will examine two claims: First, the claim that the cognitive dissonance with spacetime emergence differs *in nature* from the cognitive dissonance to be found in the philosophy of mind; second, the claim that the two situations differ because of the difference in the *degree* of cognitive dissonance we experience when looking at the primitive notions of the spatio-temporal and non-spatio-temporal theories on the one hand, and the physical and mental notions in the other hand. As we shall see, those differences are real but *do not justify* the claim that there is no cognitive dissonance to address in the case of spacetime emergence.

Claim 1: *The cognitive dissonance with spacetime emergence differs in nature from the cognitive dissonance to be found in the philosophy of mind.* Knox (2014) argued that spacetime *qualia* would have to be metaphorical in nature contrary to the *qualia* associated with consciousness, which are phenomenal entities. Indeed, there is a "what it is like to have an experience of red", but no "what it is like to *experience* space"— rather what we have in the analogy is a "what it is like to *be* space". Note that the "what it is like to be space" has nothing to do with phenomenology and merely correspond to consciousness in the analogy by the fact that it triggers a cognitive dissonance when we compare the two sets of primitive notions involved in the two compared theories. This is at least true if we focus, not on space, time or spacetime as we experience them, but rather on spacetime as we have it in the standard approach to GR. In this second context, it is right to say that there are no spacetime *qualia* in the strictest sense of a "what it is like to experience spacetime". What we have instead is a cognitive dissonance that we experience when we compare—at an intuitive pre-theoretical level—our intuitions about the two sets of primitive notions of the non-spatio-temporal and the spatio-temporal theories under consideration.

Consider again for instance disordered locality in the context of loop quantum gravity: We experience a cognitive dissonance when we compare the network of spatio-temporal relations associated with a particular volume of reality at the level of description of GR, with the

[21] And again, note that even if there is no hard problem of spacetime after careful consideration of the topic, it remains important to acknowledge the *prima facie* existence of a problem in order to address intuitions of scholars who claim that spacetime emergence is an intrinsically inconsistent idea that should not be seriously considered.

distinct spin networks or spinfoams, described by LQG. How could it be that these two networks represent the same part of reality? A natural move is to answer that the description by GR is merely approximate and that GR does not capture the richness of the true fundamental physical structure of the world. One might then argue that, as a result, we only need to derive GR from LQG (with mathematical tools and bridge principles between the primitive notions of LQG and GR) in order to explain everything there is to explain. However, and this is the important point, it is not enough to offer this derivation in order to explain *everything there is to explain*. An ontological picture is still lacking and one wants to hear a story about the (non-)existence of GR spacetime. Should we accept, being granted that there is no GR spacetime at the fundamental level, that this non-existence propagates to the derivative level, entailing that GR spacetime is an illusion, a coarse-grained structure that does not mirror the structure of reality, or on the contrary that there actually is a GR spacetime that must be related to the fundamental non-spatio-temporal structure (See Le Bihan 2018b)? If the latter, which seems a more promising path[22], how are we to understand the ontological status of the relation between the two structures?

It is important to note, however, that spacetime *qualia* would have to differ, *prima facie*, in nature from the *qualia* associated with spacetime emergence. Indeed, the *qualia* associated with consciousness capture the specificity of our *phenomenological experience* when spacetime *qualia* would merely describe intuitions we have when we look at *concepts*. This difference might explain why philosophers of physics have been inclined to neglect the importance of spacetime *qualia*. But this is wrong for two reasons—and each of these two reasons is enough by itself to show that spacetime *qualia* deserve to be taken seriously—meaning that the *prima facie* explanatory gap should be addressed in the philosophy of spacetime emergence. The first reason is that even within the philosophy of mind, it is not clear that *qualia* must be explained in terms of the qualitative specificity of our *experience*, and not as a specificity or our *concepts about consciousness*. In fact, a common strategy for the physicalist—who believes that everything is physical—is to claim that linguistic descriptions involving *qualia do* refer to physical entities and there are no *qualia* in the world; what there is, are only *qualia* concepts in natural languages. This is the

[22]In Le Bihan (2018b), I defend that the best interpretation of spacetime emergence is that GR spacetime exists and is constituted by a non-spatio-temporal structure, by analysing spacetime emergence as a form of spacetime *composition*. This approach allows making sense of both the predictive success of GR and of its non-fundamentality, without committing to a stratified ontology or a metaphysical relation of emergence.

phenomenal concepts strategy (see e.g. Loar, 1990). The view goes naturally with the *qualia* eliminativist tradition; see the seminal argument of Dennett (1988) and the most recent "illusionist" reboot of the view by Frankish (2016). A physicalist of this brand may argue that the specificity of *qualia* concepts arises from the concepts themselves—and not from experience itself. Therefore, even in the philosophy of mind, it might be that the cognitive dissonance we experience when we look at physical notions and mental notions arise from a conceptual—rather than experiential—salience.

Here is the second reason to worry about the rejection of spacetime *qualia* as an important concept. Let us admit for the sake of argument that qualitative features apply to *entities* in the philosophy of mind—say mental entities numerically distinct from physical entities—when qualitative features are about concepts or about intuitions about those concepts in the philosophy of quantum gravity—say about the concept of metric field in GR and, and the concept of spin networks/foam in LQG. What it means is that the *source* of the discrepancy is not the same. But the fact that the dissonance arises from a different source does not entail that it is not problematic. It is incorrect to argue that spacetime *qualia* should be dismissed because they do not have the same origin. In brief, the very source of the dissonance in the philosophy of mind will vary depending on whether one is a physicalist or a dualist; and, furthermore, there is no reason to require spacetime *qualia* to have the same origin as the *qualia* associated with consciousness.

Claim 2: *The two situations differ because of the difference in the degree of cognitive dissonance we experience when looking at the two cases.* Indeed, one may argue that the problem is not that spacetime *qualia* would have an origin very different from the *qualia* associated with consciousness, but rather that they would be more elusive—because of the smaller explanatory gap. Intuitively, it seems reasonable to assess the explanatory gap between spatio-temporal and non-spatio-temporal entities (or concepts) as being smaller than the observed explanatory gap between mental and physical entities (or concepts). But again, even if we admit that the extent of the gap is weaker in the case of spacetime emergence, it does not make the problem disappear. One still has to explain why there is such a gap—and this would be true even if we conceded that it would not have the same origin and the same strength as the dissonance experienced when comparing physical and mental concepts.

3 Functionalism

3.1 From Consciousness to Spacetime

Functionalism, in the philosophy of mind, aims at solving the mind-body problem by functionalising mental states, namely identifying them with functional roles realised by physical states. Functionalism aims at explaining the (or some) specific marks of the mental with respect to physical entities, namely intentionality and phenomenal consciousness. As I mentioned above, the strategy is regarded as successful when it comes to the intentional aspect of mental states. However, the predominant view in the philosophy of mind is that we may not functionalise *qualia* and physicalists rather aim at removing *qualia* from our ontological picture of the world, for instance through the phenomenal concepts strategy (Loar, 1990), or by subscribing to illusionism (Frankish, 2016).

What matters here is that functionalism is not a singular view and should be best conceived of as a *constellation of distinct positions*. This is not surprising considering the number of different notions of functions or roles one may think about: *biological functions*, *mathematical functions*, *causal roles*, etc.. Importantly for my purpose, which is to relate functionalism to the hard problem of spacetime, I will focus on two different parameters defining different sorts of functionalism. Functionalism is either *ontic* or *linguistic* and, second, functionalism is either about *roles* or about *realisers* (see e.g. Van Gulick, 2009). In this article, I shall focus on the last two distinctions only because they are the most relevant for the resolution of the hard problem of spacetime.[23] By combining the two *criteria*, we end up with three interesting sorts of functionalism about the mind, which, we shall see in the next sub-section, may be used as models to build four sorts of spacetime functionalism. Those four sorts of functionalism are: *analytic functionalism*, *occupant functionalism*, *eliminativist functionalism* and *role functionalism*.

Analytic functionalism, or linguistic functionalism, is the view that the *meanings of mental concepts* should be explained in terms of functional *concepts*. The view is about a piece of language, namely the vocabularies associated with mental phenomena. As van Gulick puts it:

> According to what one might call "analytical functionalism", mental concepts [...] can be analysed in purely func-

[23] It might be that the *a priori*/empirical distinction might play an interesting and important role in solving the problem of empirical coherence; it would be interesting to explore this in future works.

> tional terms; that is, the meanings of such concepts can be explicated in terms of conditions that can themselves be specified using only functional concepts. In contrast with ontological functionalists, who assert identities or reductions among *real-world items* such as properties, analytical functionalists assert an identity or reduction among our *ways of describing or thinking about the world* [...]. (Van Gulick, 2009, 137)

As explained in this quote, linguistic functionalism contrasts with more ontologically-loaded species of functionalism. Following a classical distinction between linguistic predicates and ontological properties[24], this view is not about the *meaning of concepts*, but about the *existence of properties* regarded as building blocks of the non-linguistic world. According to ontological functionalism, mental *properties* are offered a functional analysis, entailing that the very *existence* of mental properties is tied, one way or another, to the *existence of functional roles*.

Now, and this is important for our topic, linguistic and ontological functionalism are not necessarily exclusive. One might, for instance, believe that the right way to analyse mental concepts is to run some linguistic functionalist analysis, and that the best way to account for this situation, is to accept that linguistic functional roles track ontological functional roles. But it is possible to accept a form of linguistic functionalism without buying into ontological functionalism. This is for instance what has been done by logical behaviorists who endorsed a form of *eliminativist functionalism*. According to this view, no mental states are lurking behind the functional roles given by a functional analysis of the behavior of human agents. As Gulick puts it: "They accept the importance of holistic interdependence in analysing mental-state concepts but nonetheless regard the truth makers for mental attributions as solely facts about actual and counterfactual behaviour" (Van Gulick, 2009, 132).

The second important distinction in order to build the relevant classification of functionalisms for our current goal is between two kinds of ontological functionalism: ontological role functionalism (role functionalism for short) and realiser or occupant functionalism (occupant functionalism for short). These two sorts of functionalism are ontological not in the sense that they accept the objective reality of functional roles, but in the sense that they both appeal to the notion of function *and* say something about the nature of the relation obtaining between mental and physical entities. Actually, as we shall see,

[24]See e.g. Heil (2003).

one view—occupant functionalism—does not take ontologically seriously the existence of roles, when the other view—role functionalism—asserts the existence of functional roles.

Let us start with occupant functionalism. The view was famously endorsed by Armstrong (1968) and Lewis (1966), and is in the spirit of the *type-type identity theory* originally defended by Place (1956), Feigl (1958) and Smart (1959). According to this approach, mental states are identical with physical states. Functionalism is, then, only a tool to articulate the type-type identity theory and explain the apparent difference between mental states and physical states as a difference in the way we epistemically access to the physical states. Those different epistemic accesses to physical states shield us from a straightforward access to the properties of the entity referred to—examining the properties of the concept we are using does not suffice to access the properties of the entity the concept refers to. For instance, we discovered empirically that pain is identical with a particular neurological state; it was not possible to discover this fact *a priori* since the concept of pain does not include, transparently, descriptions of neurobiological states. But the property of pain is just this neurobiological property. Therefore, in this story, there are no mental properties "out there" in the world, numerically distinct from the physical properties. As Van Gulick puts it: "[T]he role associated with a given mental kind serves as a means to secure reference to the relevant property, but it does not typically give the identity or essence of that property, which must instead be discovered through empirical investigation." (Van Gulick, 2009, 137)

What about role functionalism? According to this view, perhaps the most standard sort of functionalism in the philosophy of mind, each *mental property* is identified with the property of playing a particular role in an encompassing network of functional roles mutually depending one on each other. Van Gulick presents the view as follows:

> The properties of *being pain* and of *playing the pain role* are regarded as one and the same property. If one thinks instead in terms of properties had by whole persons, such as that of "being in pain", the role functionalist would identify such mental properties with the property of "being in some state which plays the relevant role". (Van Gulick, 2009, 136)

In sum, we end up with three ontologically-committed sorts of functionalism:

- Occupant functionalism, which is the conjunction of analytic functionalism and an identity theory,

- Eliminativist functionalism, which is the conjunction of analytic functionalism and eliminativism about mental states and,
- Role functionalism, which posits the existence of entities, the roles, numerically distinct from the occupant of the roles.

This classification is particularly useful to address the hard problem of consciousness. The three views entail different answers to the hard problem. Occupant functionalism leads to one of the most popular forms of physicalism, namely an identity theory. In this story, mental entities (as individuated by mental concepts) are identical with physical entities (as individuated by physical or biological concepts). The functionalist story may then be put to work in order to explain why we have different sorts of access to these entities.[25]

Eliminativist functionalism offers a distinct answer to the hard problem of consciousness: mental states simply do not exist. We may use a functionalist strategy to refer to physical entities: it remains that these entities are physical. And since functional roles are merely terminological constructs, with no ontological shadows, there is not room for mental entities in this picture.

Finally, role functionalists acknowledge the existence of some entities, the realisers, tightly related to physical entities, since the mind is identified with functional roles themselves realised by physical entities. However, this connection of realisation might be as tight as one wants, it is *not* a relation of identity, and role functionalism entails that functional roles are numerically distinct from their realisers. It means that role functionalism entails the existence of at least two classes of entities: the realisers on the one hand, and the functional roles on the other hand. Then it is another question whether the functional roles should be identified with mental entities, entailing property dualism in its usual sense, or whether functional roles should rather be regarded as physical entities. The latter option avoids committing to the existence of mental entities numerically distinct from physical entities. However, if like me one is a nominalist, one will feel that those entities are dangerously closed to being abstract entities and that their ontological cost should not be overlooked in one's general ontological picture. In brief, role functionalism leads either to a dualist answer to the hard problem of consciousness since mental properties constitute a collection of entities numerically distinct from the collection of physical entities, or to a rich physicalist answer to the problem by positing the existence of ontological roles—which are not ontological

[25]One might argue that such a form of physicalism should rather be understood as a form of *neutral monism*, since the very difference between the mental and the physical is at the level of the language, and not at the ontological level. See e.g. Stubenberg (2018).

free lunches.

3.2 The Limits of Spacetime Functionalism

The situation translates to spacetime emergence with a few caveats. Here again, we may distinguish between various forms of spacetime functionalism, corresponding to the various answers to the hard problem of spacetime emergence. Role functionalists will distinguish between spacetime roles and the entities implementing these roles, keeping these two collections of entities apart. Occupant functionalists will use a form of analytic functionalism only to refer in two different ways to the same collection of entities, entailing a reductionist view of spacetime. In this picture, we refer to one set of entities under two different guises: GR and QG. And according to eliminativist functionalism, spacetime roles do not exist—they are merely theoretical constructs that refer to proper parts of the physical structure, to be described by a more fundamental theory of quantum gravity.

If *role functionalism* is the preferred interpretation of spacetime functionalism, then it comes with the *derivative spacetime view*. It entails the falsity of LW's claims 1. and 2.. First, it is not the case that spacetime functionalism is orthogonal to the hard problem of spacetime (as stated with claim 1.) and, second, it is not the case that spacetime functionalism dissolves the hard problem (as stated by claim 2.) since role functionalism solves and does not dissolve the hard problem by grounding the explanatory gap in the existence of ontological roles associated with spacetime which are numerically distinct from the non-spatio-temporal realisers. Indeed, since the derivative spacetime view based on role functionalism is an *answer* to the hard problem, this position should not be conflated with the claim that there is no hard problem to begin with. However, it entails the truth of 2*., namely the claim that functionalism may be regarded as a particular solution to the hard problem of spacetime—the derivative view—*when subscribing to a particular kind of functionalism*—namely, role functionalism.

If one wishes to adopt *occupant functionalism* instead, then it comes with *spacetime reductionism*. It entails the falsity of LW's claims 1. and 2.. First, here again it is not the case that spacetime functionalism is orthogonal to the hard problem of spacetime (as stated with claim 1.) and, second, it is not the case that spacetime functionalism dissolves the hard problem (as stated by claim 2.) since occupant functionalism *solves*—and does not dissolve—the hard problem. Indeed, since spacetime reductionism is an *answer* to the hard problem, this position should not be conflated with the claim

that there is no hard problem to begin with. However, it entails the truth of 2*., namely the claim that functionalism may be regarded as a particular solution to the hard problem of spacetime—an identity theory—*when subscribing to a particular kind of functionalism*—namely, occupant functionalism.

And likewise for eliminativist functionalism: it entails the falsity of claims 1. and 2. since this approach is not orthogonal to the hard problem. It entails the truth of 2*: functionalism may be regarded as a particular solution to the hard problem of spacetime—eliminativism—*when subscribing to a particular kind of functionalism*—namely, eliminativist functionalism.

We may now specify the claim 2* as follows: functionalism may be regarded as a a particular solution to the hard problem of spacetime *when subscribing to role functionalism, occupant functionalism or eliminativist functionalism.* Alternatively, if one does not want to commit to any specific ontological form of spacetime functionalism, then one has no other choice than endorsing *analytic functionalism.* As a result, this view does not solve or dissolve the hard problem of spacetime emergence—it simply does not say anything about it. We may now refine claim 1* as follows: functionalism may be regarded as a view orthogonal to the hard problem of spacetime *when subscribing to analytic functionalism alone—and not to role functionalism, occupant functionalism or eliminativist functionalism.*

What about the claim 2** that I made in the introduction, namely the claim that functionalism helps to solve some—but not all—problems of spacetime emergence? Functionalism, in a non-specified form—as the disjunction of analytic functionalism alone, analytic functionalism plus an identity theory, analytic functionalism plus eliminativism and ontological functionalism—should be enough to solve the problem of empirical coherence along the lines suggested by LW since this issue only requires individuating and relating functional roles in GR and the world as we ordinarily perceive it to entities posited by the more fundamental non-spatio-temporal theory—not to take a stance on what there is. More precisely, the view here is that since analytic functionalism can easily be associated with a specific ontological view about what there is (identity view, eliminativism) or be reified into ontological functionalism, functionalism, as a coarse-grained view, can solve the problem of empirical coherence with no further mention of one of the fine-grained species of functionalism. The problem of empirical coherence, if LW are right that functionalism can solve it, could thereby be solved by remaining neutral with respect to the ontological problem and the hard problem.

As a conclusion to this section, let us consider a possible objection

to the general strategy I have been following in the essay—namely, to offer a fine-grained classification of functionalisms—in order to assess how functionalism can relate to the hard problem of spacetime emergence. One might perhaps argue that we should *not* distinguish between these various sorts of functionalism and that this stipulation would prevent the very hard problem to appear in the first place. But what reason would we have to accept this stipulation? Arguably, one must at the very least provide a justification for this claim that we should not distinguish between the fine-grained sorts of functionalism. As long as such a justification remains wanting, and noting that it is possible on purely *a priori* grounds to come up with a distinction between ontic and linguistic roles, such a move appears illegitimate.

4 Conclusion

Functionalism cannot be both orthogonal to the hard problem of spacetime and make it go away. Any functionalist must either remain silent about the hard problem or solve it by subscribing to a particular form of functionalism that entails that spacetime *does* or *does not* exist, namely to a particular solution to the ontological problem. This clarification should help both friends and foes of spacetime emergence to articulate their arguments with more care. For instance, a friend of spacetime emergence willing to answer to the problem of empirical coherence by appealing to the view that spacetime is derivatively real (cf. Wüthrich, 2017, 298) should be aware that this moves commits them to a particular answer to the hard problem of spacetime. Or, alternatively, opponents to spacetime emergence claiming that spacetime must be fundamentally real should be clear on which view on the hard problem of spacetime, implicitly assumed in the background, justify their claim—arguably, they must have in mind that a derivative spacetime view is not a genuine option. Otherwise it is unclear why they would feel compelled to adopt the view that spacetime must be fundamentally real to begin with.

Spacetime emergence has been discussed with respect to empirical issues as the problems of empirical coherence; more metaphysical issues have been put aside. However, philosophers debating spacetime emergence through the lens of functionalism should adopt a clear view on the ontological picture they are relying on, if only for the sake of clarify and consistency of their proposal. They must adopt either one of the three substantive views—an identity view, a derivative view or an eliminativist view—or a neutral form of analytic functionalism which remains completely silent about the ontological implications of spacetime emergence. Therefore, I urge the friends and foes of space-

time emergence to focus attention on the hard problem of spacetime emergence—a novel issue that stands on its own ground and may not be solved or dissolved just by claiming that spacetime is a functional structure.

As spacetime functionalism, in its most general form, does not tell us what spacetime does, the view that "spacetime is as spacetime does" does not tell us what spacetime is. Spacetime might still be eliminated, reduced to a more fundamental structure or exist in a non-reductive way by being ontologically implemented by a more fundamental structure—all these views are consistent with spacetime functionalism.

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