Research Article

Causal Principles in Material Constitution: A Philosophical Inquiry into the Composition of Objects

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This manuscript delves into the philosophical debate surrounding the Special Composition Question (SCQ), focusing on the causal relationships between objects and their constituent parts. By distinguishing between Weak and Strong Causal Composition, the article explores how causal mechanisms underpin the composition of objects. Theories from notable philosophers, including van Inwagen and Leibniz, are evaluated. This study seeks to bridge the gap between common sense perspectives and principled ontological theories by introducing the concepts of Weak and Strong Causal Composition. The analysis reveals how a causal approach can offer insightful resolutions to longstanding debates in mereology and ontology, emphasizing the role of causality in understanding the essence of material composition. The proposed causal perspective encourages further philosophical inquiry into the foundational principles governing the composition of objects.

Introduction

The question of Material Constitution asks for the relation between a thing and what it is made of, e.g., "What is the relation between a clay statue and the lump of clay from which it is made?" (Wasserman, 2002, p. 197). A second question in this vein is what the relationship is between the lump of clay and the molecules it is made of. In a reductionistic manner, we can form additional questions concerning relations between molecules and atoms, as well as relations between atoms and elementary particles. One aspect of this is whether "*Constitution is Identity*" (Noonan, 1993, p. 133). On that account, the statue would be a lump of clay. Another aspect is what individuates a thing. We see the thing clearly when we look at the statue and also when we look at the lump of clay, but when it comes to molecules and atoms, it is not that certain what 'a thing' would be.

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What individuates a thing has to do with "the Special Composition Question" (van Inwagen, 1987, p. 23, 1990, 1993a), which asks, roughly, what it takes for some *x*s to compose some *y*. In this paper, I will concentrate on the Special Composition Question (SCQ) concerning physical objects. A special focus is on *organisms*, i.e., biological 'things'.

Much work in relation to SCQ has addressed its main feature of 'what it takes' (for some *x*s to compose some *y*). van Inwagen, e.g., stated that "the *x*s compose [some] *y* if and only if" "the activity of the *x*s constitutes a life (or there is only one of the *x*s)[1]." (1990, p. 82). Two other major lines of suggestions are 'Universalism' and 'Nihilism,' where the former argues that any *x*s compose a *y* and the latter asserts that no two or more *x*s compose a *y*. A fourth approach is that composition is a brute fact (Markosian, 1998a). Of these four conceptions of SCQ, only the last one in a reasonably fashion saves what is called 'Ordinary Objects' as "dogs and cats, tables and chairs, trees and their branches, and so forth." (Korman 2014). van Inwagen's proposal saves dogs and trees, but all non-organic 'things' will go on his account. It is not fair to say that 'Universalism' does not save ordinary objects, but since universalists "typically [will] accept that there are such extraordinary objects as *trout-turkeys*, where a trout-turkey is a single object composed of the undetached front half of a trout and the undetached back half of a turkey" (Korman 2014), and all sorts of other kinds of non-ordinary objects, the ordinary objects, on the universalist view, are saved to a high price.

In addition to Markosian's 'brutal' approach in saving ordinary objects, Carmichael (2015) suggests a 'common sense' view that permits "the most obvious objects in our immediate environments (e.g., tables, chairs, organisms, and the like) [to] exist, while the extraordinary universalist objects (e.g., pinky-moons) do not." Carmichael's idea is that either "the xs are lump-like and the xs are bonded," or the activities of the *x*s "constitute an event that imposes sufficient unity on the xs." It seems here that Carmichael draws on van Inwagen's ideas about life and SCQ. Indeed, Carmichael exemplifies the second disjunct with: "the event which is your life is constituted of the activities of the simples that make you up," and adds (footnote 10) that "I mean 'life' in the narrow biological sense, which is worked out at some length by van Inwagen (1990: §9)."

In sum, there are what van Inwagen calls *extreme* answers – answers that either give an *unrestricted* view on composition or deny the possibility of composition – and *moderate* answers, where we have seen examples from van Inwagen and Carmichael. What it takes for some *x*s to compose some *y* is a question that goes beyond mere mereology into ontology, since it could be argued that the answers to SCQ state what (composite) objects there are. Indeed, Potrc (2002, p. 197) states that the

> "Special Composition Question (SCQ), as a basic ontological and mereological quest, invites two kinds of answers. Either we assume the correctness of common sense, or we go for some principled answer that may be incompatible with it. But there are doubts as to the ontological viability of common sense posits. So a principled answer to SCQ seems preferable. The Non-Arbitrariness Of Composition (NAOC) delivers a guide here, being a kind of meta-ontological principle that urges you not to posit a multiplicity of independently existing and individually unexplainable facts. NAOC requires generality and systematicity as the basis of ontology."

My aim is to suggest and defend a principled answer in line with Potrc's demands, conscious of risking one or two common sense objects. My suggestion is that it is worthwhile to try a *causal* stance towards the question of what it takes for some *x*s to compose some *y*. Causality is also something that has a common sense appeal. van Inwagen, though, when he coined the Special Composition Question, raised serious doubts concerning the possibility of a moderate causal answer. On the one hand, he concludes that "any plausible Moderate answer to the Special Composition Question will identify the relation expressed by '∃y the xs compose y' with some causal relation." (van Inwagen, 1987, p. 41). On the other, hand he thinks that

> If any causal answer is correct, then the vagueness inherent in multigrade causal relations like ***being in contact*** **and** ***being fused*** will infect notions like existence, number, and identity, that, one would have supposed, cannot, because of their pristine logico-mathematical character, admit of the least tincture of vagueness. (p. 44)

van Inwagen states, in effect, that "any [correct] causal answer" implies an unacceptable vagueness. So, if van Inwagen is right, both non-extremists and a moderate causal style answer would be in trouble.

Causal Composition

Weak Causal Composition

My causal style SCQ answer has a common sense appeal by suggesting a causal principle underlying composition. It has several features, though, that are incompatible with common sense. A first, perhaps appealing, feature of my suggestion is that composition has to do with underlapping causes.

If two things underlap they both belong to a common third. My pencil and my coffee cup underlap the things that are on my desk, for example. This causal stance can be used to give a version of the Universalist unrestricted composition view. If we say that some *x*s compose a *y* if and only if their causes underlap, and if all causes go back to a cosmological 'big bang', then any set of arbitrary physical things would compose an object. This view I will label the Thesis of Unrestricted Weak Causal Composition:

Thesis of Unrestricted Weak Causal Composition:

Some xs compose a y iff (if and only if) the xs have underlapping[2] *causes.*

If all causes of physical things go back to a cosmological 'big bang,' then all things always underlap in one way or another. With the thesis of unrestricted weak causal composition, Universalism, or unrestricted composition for the physical domain, can be explained: any *x*s compose a *y* since their causes underlap. Concerning NAOC, though, we do have a general principle, but it seems too permissive as to what wholes it entails. One way of restricting the weak thesis is to demand that *all* parts that underlap compose the whole. In the physical domain, that would be the whole universe if all causes go back to the big bang. Without a restriction, again, we cannot delimit the object. The unrestricted weak thesis allows any set of subparts of a given object to compose an object. A moderate SCQ answer, therefore, needs an expansion of the vocabulary. I will go into that later but first formalize the restricted version of the weak thesis.

If we want *all* parts with underlapping causes to be part of the whole, we can form the set of the *x*s and deny parts that do not belong to the set from having causes underlapping the causes of the parts of the set. Here I will do that by first stating a set consisting of *all* (physical) parts. From that set, I, second, will pick out a set of *x*s that have underlapping causes. The set of *x*s is formed so that it includes all parts that causally underlap. Before we can go on, *nota bene*, it must be settled what kind of parts we are talking about and what kind of causality is being used. Concerning parts, I in a most simplistic way will assume that the kind of parts that is focused on is parts that are *caused*. Furthermore, I will assume that these parts are *discrete*, that they are individuated. Hence, the parts that are discussed can be defined primitively:

Definition of Part*: A Part =* $_{df}$ *A coherent causal difference.*

Since all parts in the physical domain underlap, it is not crucial how we conceive of parts in relation to the weak thesis. It will be important in later developments of the thesis, though. In the next section, on parts, I will discuss two potential areas where this primitive notion of part is of interest. Those areas, also, are of special interest concerning the *kind* of causality that is being used here. It must be said upfront, though, that it is not *sure* that the kind of causality that is being used here has correlation with any *actual* cause. The way to conceive of causality in this context is the straightforward one that there is *one cause* for *one coherent causal difference*, i.e., for one part. This means that on this account the part really is the *effect* in the notion of *cause-effect* and that the causes of the discrete parts also are discrete. This is formulated in the following thesis:

> ***Causal thesis**: A coherent causal difference is discrete and has a discrete cause.*

Given discrete parts and discrete causes, we, on a considerable abstract level, can conclude that there is a bijective relation between parts and causes and that both parts and causes are enumerable. The restricted weak thesis of causal composition now can be formulated if we let U be the set of all physical parts and let X be the set of 'some *x*s'. Also, let X^C be the set defined as the *complement* $U \backslash X$, consisting of the parts that do not belong to X. Then the restricted weak thesis is the

> ***Thesis of Weak Causal Composition:***
>
> *Some xs compose a y iff the xs have underlapping causes and no cause of the elements of X^C underlaps any cause of the elements of X.*

If all physical parts go back to a big bang, they have a common origin, wherefore on this account X^C is empty[3] and the only object there is is the 'blobject'[4], i.e., the (whole) universe. This was Parmenides' view on "The Strict Monist Interpretation" of Parmenides' writing: "A good many interpreters have taken the poem's first major phase as an argument for strict monism, or the paradoxical view that there exists exactly one thing, and for this lone entity's being totally unchanging and undifferentiated." (Palmer 2012)

Thus, we on the unrestricted and the restricted weak causal composition views can account for two principally important answers to SCQ, the Universalist and the 'blobject' answers. As we will see below, the causal stance can also account for the other two popular views 'on the market,' as it is put in the following citation:

Recent discussions of the mereology of physical objects have focused mainly on the question of when several objects compose a further object. According to the most popular view on the market, there is a physical object composed of your brain and Jeremy Bentham's body [Universalism]. According to the second-most popular view on the market, there are no such objects as human brains or human bodies, nor are there atoms, rocks, tables, or stars [Nihilism]. And according to perhaps the third-ranked view, there are human bodies, but still no brains, atoms, rocks, tables, or stars [van Inwagen's proposed answer]. (Markosian, 2014)

In order to account for Nihilism and van Inwagen's proposed answer (VIPA), the causal account can be developed to become stronger.

Strong Causal Composition

To take the next step, we can compare underlapping causes with kinship. The weak thesis is like kinship *per se*, and since there is a danger that all beings are related, the weak thesis is not that informative. A more restricted kinship is 'descendants to *x*', e.g., descendants to Plato or the present king of Sweden. On this view, an 'object' composed of 'some *x*s' could be 'the descendants of the present King of Sweden' or 'the descendants of Plato'. The strictest version in this vein is 'offspring,' which confines the 'object' to the children of a given person, e.g., 'the children of Plato.' For underlapping causes, this yields a thesis in which the causes of the parts of the object are related in a way so that there are no intermediate causes.

If we have two causes *x* and *y* of two parts, A and B, and the causes underlap, then there is a *z* such that *x* is part of *z* and *y* is part of *z*. This is the weak thesis. To restrict it in order to exclude all intermediate causes, two causes have to have a stronger connection than mere underlapping. *If* causes are underlapping, to restrict the thesis in the desired way, we can begin by *defining a binary predicate* that picks out *pairs* of parts that are related in a way that guarantees that there are no intermediate causes, i.e., a predicate that ties two parts to each other by underlapping causes with no intermediate cases. Such a predicate P, in the 'kinship' version, would imply that if *x* and *y* are P, then if M is the mother[5] of *x*, then M is the mother of *y*, and also the other way around; if M is the mother of *y*, then M is the mother of *x*. Thus, Pxy iff (M is the mother of x iff M is the mother of y). In our case, a sufficient definition states that one cause underlaps the other if and only if the other cause underlaps the first one:

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Definition of a Causally Unifying Binary Predicate C of Parts[6]***:***

C*xy* $=_{df}$ *There is a z such that (the cause of x belongs to z iff the cause of y belongs to z).*[7]

The predicate **C**, thus, picks out causally coherent differences whose causes two by two have a "*minimal* underlapper." [8]. Since **C** is reflexive, **C**pp is true for all parts p. Again, we do not know beforehand that any two separate parts comply with **C**. Even so, a strong causal thesis of composition now can be stated that gathers *all* parts that have the same minimal causal underlapper in the defined sense:

Thesis of Strong Causal Composition:

Some xs compose a y iff for any two differences x_1 *and* x_2*, holds* $\mathbf{C}x_1x_2$ *and for no w of the elements of* X^C*, holds for any of the xs* **C***xw (or there is only one of the xs).*[9, 10]

This strong thesis is a moderate answer to SCQ. With the strong thesis, it is possible to account for Nihilism and VIPA. In order to account for Nihilism, we simply suppose that there are not any non-identical pairs of parts x_1 and x_2 that have a minimal underlapper in the sense of the strong thesis. Then, according to the strong thesis, there are only *y*s composed of exactly one part (there is only one of the *x*s), and hence there are no composite objects. To account for VIPA, we can set out suitable conditions for the parts. First, I will suggest that parts of living things are *biological reactions*. Since there is no absolute consensus as to what 'life' really is, I cannot attest to the validity of the following individuation thesis.

Individuation Thesis for Biology*: A part of an Organism* $=_{df}$ *A Biological reaction*[11]

An argument in support of the thesis, in the present context where the unifying composition principle is that the parts have underlapping causes, is that biological reactions, supposedly, might be coherent causal differences towards each other. Given any biological reaction, there are others both preceding it and succeeding it (except for a first and a last one). A more comprehensive rationale for this individuation thesis is discussed in the next section. Second, to account for VIPA, we equal 'life' with a biological organism. The organism is, according to the individuation thesis for biology, composed of biological reactions. Combining the individuation thesis with the strong thesis, we get:

Strong Causal Definition of Life: *Some xs compose a life iff the xs are biological reactions and for any two biological reactions* x_1 *and* x_2*,* $\mathbf{C}x_1x_2$ *and for no w of the elements of* X^C *holds for*

any of the xs Cxw (or there is only one of the xs).

So, on the causal views of composition, we have accounted for Universalism, Nihilism, VIPA, and the 'blobject' view. Before looking into the difficult project of trying to tie the strong thesis to science, which is the topic of the two next sections, I will show the thesis' strength in handling the vagueness objection that is a threat to all moderate causal-style SCQ answers. Since van Inwagen's proposed answer to SCQ is moderate, though perhaps not as extreme as the view leading to the 'blobject', he sets out to defend his answer against his own objection concerning the inherent vagueness of causal-style moderate answers. He does so by focusing on the very vagueness and suggests to "work out an account of vagueness that is compatible with a [/his own] causal answer to the Special Composition Question" (1987, p. 45). In 1990, he presented an account of vagueness that, in his eyes, was compatible with his causal answer to SCQ. In the account, he defended his proposed answer to SCQ against The Problem of the Many[12], which is a threat to any moderate SCQ answer based on the vagueness of identity in relation to material constitution. On van Inwagen's account[13],

> "what composes me is a fuzzy set of particles, and one and only one fuzzy set of particles is qualified to compose me. A fuzzy set is simply a set that has three or more degrees of membership - as opposed to the two degrees of membership (Yes and No) that figure in the specification of a classical set." (van Inwagen, 1993b, p. 713)

Sider Sorites

van Cleve makes a vagueness objection against any moderate SCQ answer, which he calls 'the Sider sorites'[14]. I will defend the strong thesis against van Cleve's objection by blocking it. This block does the work also against van Inwagen's objection[15]. I cite the whole argument (van Cleve, 2008, p. 328):

> P1 If in some cases composition occurs and in other cases it does not, then there are cases in which composition occurs that are connected by a continuous series with cases in which composition does not occur.
>
> P2 There is no sharp cut-off point in any such series. That is, there is no pair of adjacent cases such that composition (definitely) occurs or it (definitely) does not occur.
>
> P3 It is always determinate whether composition occurs. That is, in every case, either composition (definitely) occurs or it (definitely) does not occur.

Conclusion: Either composition always occurs or it never occurs.

To block the sorites, I focus on P1 and leave P2 and P3 as supposedly acceptable. The objection from this sorites to the strong thesis' restricted account of composition is that 'according to the strong thesis, there are cases in which composition occurs that are connected by a continuous series with cases in which composition does not occur'. But how could that be? The strong thesis claims that some *x*s compose a *y* iff for any two differences x_1 and x_2, $\mathbf{C}x_1x_2$ and for no *w* of the elements of X^C, **C**xw (or there is only one of the *x*s). So, we have two cases: either

i. there is only one of the *x*s, or
ii. every combination of pairs of *x*s is related by having the same causal minimal underlapper while nothing but the *x*s have that relation to any of the *x*s.

Now, for the objection to be valid, either i) or ii) must make possible that there is a continuous series that leads from it to its opposite. But that is not possible since in the first case the object either is or is not with no intermediates, and in the other case the object is a partition (partitions have no intermediates) of all coherently causal differences, i.e., *parts*[16]. Therefore, the Sider sorites is blocked against the strong thesis.

Now, with the 'easy' part done, I will make a try to make intelligible the strong thesis.

Causal Parts

To find the conceptually here conceptualized 'causally coherent differences,' I start with a quick glance at Huneman's (2014) paper entitled *Kant vs. Leibniz in the Second Antinomy: Organisms Are Not Infinitely Subtle Machines*. My strategy is to put pressure on regression, and especially causal regression, within the physical domain. The basic question is what we will find at the end of the line: an end or no end, something we could name a 'part' or atomless gunk[17]? The notion of a coherent causal difference could do with something 'part-like,' at least when accounting for basic composites, if there are such. The regression project is also important in another vein: if there are coherent causal differences, then there perhaps is some order when we look along the regression line; it is like when we cut a drop of water in halves: can we keep on cutting endlessly, or is there something that could stop us; in this case, some line after which the very water disappeared? Or, concerning matter, can we keep on dividing endlessly? Huneman discusses this very question in relation to Kant's critique of Leibniz's notion of organisms.

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> Leibniz thought that, contrary to the machines made by us, living creatures are "natural machines" (which means "infinitely organized machines"). ..."... A natural machine is still a machine in its tiniest part ..."Hence, the difference between machines and organisms is the difference between finite and infinite organization (Huneman 2014, pp. 157-158).

So, on Leibniz's account, organisms are endlessly dividable and yet in "its tiniest part" organized (as organisms). If we put this in the light of physics, this could translate to the view that 'if we cut a piece of matter in halves, we can go on cutting it in halves endlessly and still have matter in each half'. Concerning organisms, Kant objects to Leibniz's view in arguing that "wholes then seem *composed* or *constituted* of parts" (Huneman 2014, p.171) and that " "[c]onstitutive parts" means that the parts are determined; hence, the identities of the parts and their boundaries are somehow fixed, and therefore the decomposition is no longer possible." (Huneman 2014, pp. 171-172). "That is why for Kant, division goes with "decomposition": a division picks out parts, thereby dismantling the composites". (Huneman 2014, pp. 171). "It follows that the body is thereby infinitely dividable, but not constituted of an infinite number of parts." (Huneman 2014, p. 171). Huneman expresses the core of what I am driving at here, and I let him use his own words:

> This common ground could now be expressed by saying that both the Thesis and the Antithesis conceive of divisibility as being identical with composition; they just differ on whether composition stops at simple parts or not. In effect, in the Thesis, the entity – whose matter is supposed to be prior to space – is a composite, and the division naturally divides it into the elements that compose it; hence, division and composition are the same. And in the Antithesis, the result of division is precisely those spatial parts that, in turn, constitute the composite which is supposed to be essentially in space. Saying that division occurs through regress (which is the critique's position) – hence that constitutive parts are not given – means that division and composition are different. (Huneman 2014, p. 174)

One strand here is that matter either is dividable infinitely or not. In the latter case, matter has 'simple parts' that cannot be divided further. This strand concerns fundamental physics and the basic units of physical objects. Another strand is that division and decomposition are different. On that strand, there are wholes 'out there' to be accounted for. One kind of wholes, on Huneman's account, is the

> organized beings[,] ...are subject to two kinds of divisions: (a) as organized beings, they undergo decomposition into organized parts, which in the end should stop with inorganic parts ...; (b) as appearances in space ... reason prescribes the rule of always continuing the regress from whole to parts in regards to extended matter (Huneman 2014, p. 180-181)

In my attempt to tie the strong thesis to science, I will follow both leads, starting with biology.

Biological Simples

If the decomposition of biological organisms "in the end should stop with inorganic parts," we might have a demarcation line between organic and inorganic parts concerning the organism. Then it could be argued that it is the organic parts that compose the organism. But how are we to accomplish the very decomposition? Using the knife will not ascertain that what we carve out are biological parts. Kant uses reason to be assured that there is some kind of demarcation line:

> In contemporary biology, we have an example of ... decomposition of an animal into organs, tissues, cells, or of the chromosomes into genes, nucleic acids, nucleotides, etc ...; the Kantian argument says that we know empirically that the unorganized parts are the nucleotides, but we know a priori that there will be unorganized parts. (Huneman 2014, p. 180)

A third option is science, where we combine observation with theory. When we operate from a causal perspective, the question remains if the causal decomposition of the organism 'stops with inorganic parts'. On that account, we conceive of things as being caused, and some of them are biological while some are not biological. Now, if the strong causal thesis of life is valid, an inorganic causally coherent part of something constituting an organism is not a biological reaction, whereas an organic causally coherent part is a biological reaction. On that account, the biological reaction might have a mereological structure so that more than one reaction composes a composite reaction[18], whereas there also would be *atoms* of the biological parts consisting of non-composite biological reactions – *simples* of biology.

Markosian defines *simple* out of the concept of *proper parts*. On one intuition of the relation between parts and wholes, every part is part of itself (reflexivity). If we have something made of more than one part, we could define 'x is a proper part of *y*' as "x is a part of y but y is not a part of x" (Markosian,

1998b, p. 214). With this notion, we can define a mereological simple *x* as "x has no proper parts" (ibid.). As Markosian, I think, rightfully argues, there is a strong link between SCQ and the notion of simples:

> "The notion of a mereological simple (hereafter I will just say 'simple') is crucial to discussions of composition because simples are the basic building blocks that, when combined in various ways, make up all other objects. Thus it is natural to think that what we say about the nature of simples will have considerable bearing on what we say in response to the Special Composition Question. For this reason, it is natural to ask the question, Which things are simples? That is, Under what circumstances is it true of some object that it has no proper parts?" (Markosian, 1998b, p. 214)

On a common sense view, "the event which is your life is constituted of the activities of the simples that make you up" (Carmichael, (2015)). The crucial thing here, in the present context, is if the 'simples' of life are biological or not biological. On my suggestion, it is possible that the simples, as reactions, are biological.

Physical Simples

The second strand is that matter either is dividable infinitely or not and that in the latter case matter has 'simple parts' that cannot be divided further. So we shift focus from organisms to quantum physics. Here, I am going to discuss a rather new theoretical development which means that the outcome depends on that particular theoretical perspective and not on 'quantum physics' as such. The theory in question makes possible a straightforward notion of physical simples.

Markosian proposes that "[physical] simples are maximally continuous objects." (1998b, p. 221) I will not penetrate all the parts of the definition he gives of that notion but concentrate on the first part (ibid.): "x is a maximally continuous object = $_{df}$ x is a spatially continuous object and there is no continuous region of space, R, such that (i) the region occupied by x is a proper subset of R". If simples are 'maximally continuous objects,' the cited part of the definition makes possible that simples are simples – as defined by having no proper parts – in virtue of their dimensional properties, i.e., the region (of space) they occupy has no regional subparts. On this view, simples are simples-as-having-no-proper-parts since they occupy the smallest possible space. [19]

Loop quantum gravity is a line of theory trying to integrate "quantum physics and general relativity theory" and "string theory is still the best candidate, with 'loop quantum gravity' as its strongest rival" (Kuhlmann, 2014). Loop quantum gravity fits perfectly with the view of *simples* where simples are 'simples-as-having-no-proper-parts since they occupy the smallest possible space'. "Loop quantum gravity predicts that space comes in discrete lumps, the smallest of which is about a cubic Planck length, or 10^{-99} cubic centimeters. Time proceeds in discrete ticks of about a Planck time, or 10^{-43} seconds." (Smolin, 2014, p. 96) On this account, we have a candidate for a simple to build upon concerning SCQ tied to the physical domain: the simple is the volume of a cubic Planck length. On the loop quantum gravity account, "space is an emergent description of relations between particles" (Smolin, 2008, p. 7) [20], so a volume of a cubic Planck length is not just 'space' but is the smallest physical particle on the account.

Loop quantum gravity is a 'background independent' theory, a feature I will explain next. The basic question concerns the relation between space and matter and is about whether space is absolute or relational, which is to ask if the relation between space and matter is static or dynamic. Smolin (2008) describes a background to the question in a section called "A brief history of relational time" (pp. 6-9). The story starts at the time when Newton published his *Principia Mathematica*. While "Leibniz espoused *relational* notions of space and time, according to which space and time are to be defined only in terms of relationships among real objects or events," Newton "espouse[d] an *absolute* notion of space and time, according to which the geometry of space and time provided a fixed, immutable, and eternal background, with respect to which particles moved." "Leibniz's argument for relationalism was based on two principles" of his, [t] he *principle of sufficient reason*" and "the identity of the indiscernible." The former "states that it must be possible to give a rational justification for every choice made in the description of nature" and "[a] theory that begins with the choice of a background geometry, among many equally consistent choices, violates this principle." Thus one can ask "why is the universe where it is, rather than ten feet to the left, or rotated 30 degrees? Or, why did the universe not start five minutes later?" "As there can be no rational answer why the universe is where it is, and not ten feet to the left, the principle of sufficient reason says this question should not arise in the right theory." The second principle of Leibniz, the identity of the indiscernible, "states that any two entities which share the same properties are to be identified." So if we have two alternatives, that the universe is where it is or "10 feel to the left" and "they cannot be distinguished," "[t] he principle says that they must then be identified." Since the absolute view on space cannot

account for this, "[o] ne response is to demand a better theory in which there is no background spacetime."

Given this vignette as a *raison d'être* for loop quantum gravity[21], I will now build upon it in order to make intelligible the notion of a coherent causal difference. Thus, if loop quantum gravity is right, the smallest possible lump of a physical 'thing' has the size of the Planck cube. Also, on the loop account, the Planck cube-sized 'thing' is not 'enduring' in time. Perhaps it is 'perduring'[22], but that could be too soon to say since "[t]hough quantum gravity has been the subject of investigation by physicists for over eighty years, philosophers have only just begun to investigate its philosophical implications" (Weinstein and Rickles, 2014). Since on the loop account 'time proceeds in discrete ticks of about a Planck time,' the quantum lump *is not continuous* from one tick to the other. Therefore, on a 'causal composition loop' account, it is possible to say that the-Planck-cube-sized-quantum-lump-in-a-discrete-Planck-time-tick-*one* is different from the-Planck-cube-sized-quantum-lump-in-a-discrete-Planck-time-tick-*two*. They, in short, could be seen as two distinct (as in discrete) parts. Now, to take the step to the notion of causally coherent differences, we just replace 'parts' with 'causally coherent differences' and get that the two are causally coherent differences. By this, we have defined a notion of physical simples.

> ***Definition of a physical simple:*** *A physical simple* $=_{df}$ *A Planck cube-sized quantum lump in a discrete Planck time tick.*

Now, to visualize the scene, imagine a chessboard filled with physical simples (see figure 1). The rows go from *1* to *8* and the columns go from *a* to *h*. Next, we let the columns symbolize differences in time and the rows symbolize differences in the three dimensions of space. For instance, column *a* has eight slots representing eight different times[23] (from *1* to *8*), and row *1* has eight slots representing eight different places[24] (from *a* to *h*). *Now we have to make a choice*: either we say that exactly *one* slot marks a simple, or we say that *more than one* slot marks a simple. The most obvious choice – and the one stated in the definition above – would be to say that *one* slot marks a simple and not that more than one slot marks a simple. This choice comes with a price: we have to account for the union of the simples concerning time.

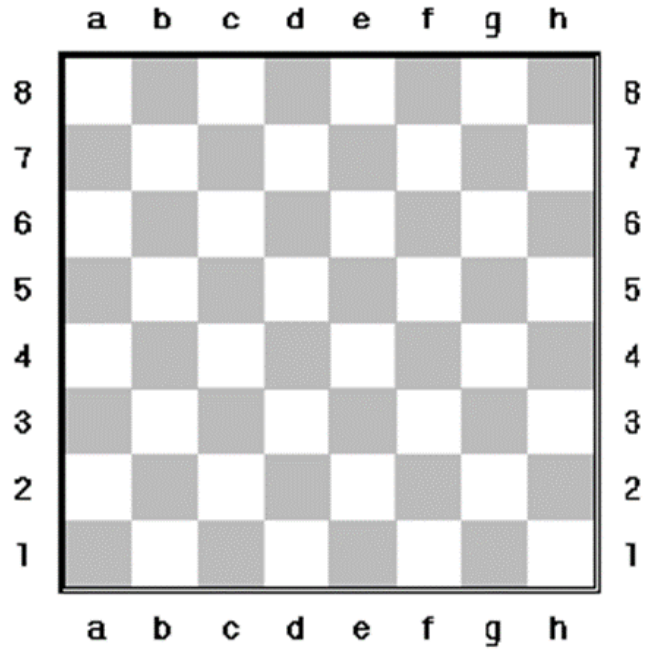

Figure 1.

On this account, we not only must ask *Why this lump here and now?,* but also must ask *Why this lump in these units of time?* To put it another way, the SCQ has to do with horizontal unification (on the chessboard) as well as *vertical* unification.

The individuation question concerning parts, therefore, should be linked to this fundamental relation between simple and simple along the column of the chessboard. I do not think that it is viable to question the relation, and I think we can use it as a template to make intelligible other part-whole relations. The SCQ has to do with *why* simples[25] pile up, and the individuation question should ask *which simples* pile up. Thus, in the starting position, we have a simple, big as a cube with each side with the Planck length. In a discrete situation, we have a simple with the same size. If we go back to the chessboard, we say that simples along a row are simples separated in space and that simples along a column are simples separated in time. The simples separated in space, we could argue, are *different* simples, whereas the simples separated in time are ... what? My suggestion is that simples separated in time are *different parts* of the *same object*. On this totally fundamental level of physics, according to this view, objects are evolving in time, composed of separate parts; the simples of the quantum level, see fig. 2.

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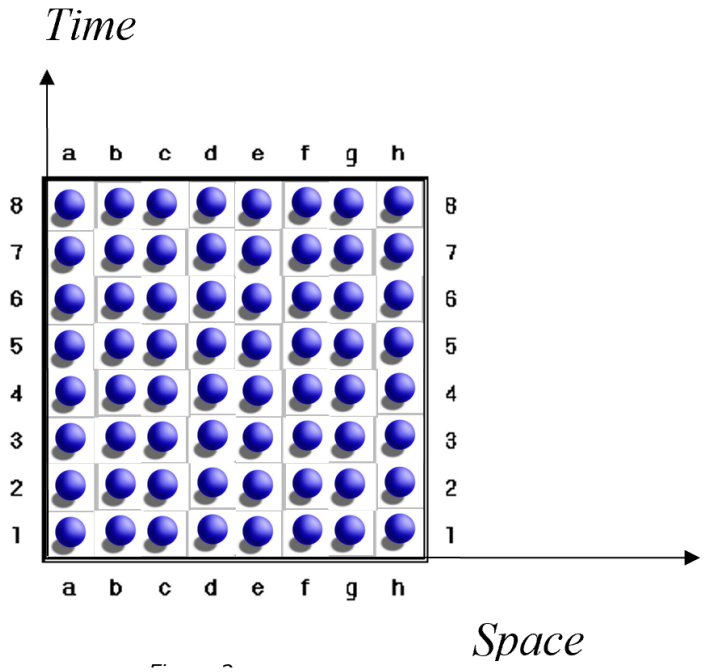

Figure 2.

On this account, therefore, quantum objects consist of quantum simples evolving in time. Each simple is a coherent causal difference, and thus, each simple has a cause. On the chessboard, e.g., there are eight causes to be accounted for by physics, one for each column. [26] In the next section, we go on to look at the unification of simples evolving in time.

Causal Wholes

On the loop quantum gravity view, as conceptualized here, simples evolve in time in discrete steps. Thus, at each moment (defined as the Planck time), there is a simple. On my view, we have to account for this evolving in time. Actually, there are two things that are important to stress regarding the evolving of quantum simples. On the one hand, the first simple of a quantum object has a cause – at least that would be a way of holding on to Leibniz's *principle of sufficient reason*. *What* that cause could be is a question for physics. If, though, a quantum simple emerges, and if we hold on to the principle of sufficient reason, there is sufficient reason for that emergence. To be perfectly clear here as to what I am after, it could be unsettled whether or not an emerged quantum simple has sufficient reason. If, though, the simple *has* sufficient reason, I would like to *define* it as a cause.

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Definition of Cause of an Emerged Quantum Simple: If an emerged quantum simple has sufficient reason, that sufficient reason is (here defined as) its cause.

On the other hand, if an emerged quantum simple evolves in time – and if we thus have *parts* of a hypothetical quantum *object* made up of *simples* – we, on my view, have to account for this. What we have are simples evolving in time (see figure 2), starting with a first one (the emerged quantum simple). We can exemplify this with an emerged quantum-sized part. The quantum object composed of the evolving simples is the simples as existing in discrete time units of the Planck time. *Why* is this evolving? For one thing, going back to the definition of *part*, the evolving simples-as-parts are 'coherent causal differences'. If we cut out a piece of the evolving quantum object, say ten simples, those ten simples are discrete parts with ten unique causes (on the present vision). In the same way, a partition of only two simples has two unique causes. On this fundamental level of physics, it is, I hope, possible to envision a scene with one first simple of a quantum object. 'First', naturally, is a complex notion. I do not here necessarily mean that it is the first quantum simple as in the very first quantum simple. Instead, we can focus on an emission of a photon from an electron during its transition from one orbit to another as it moves around a hydrogen nucleus (see figure 3).

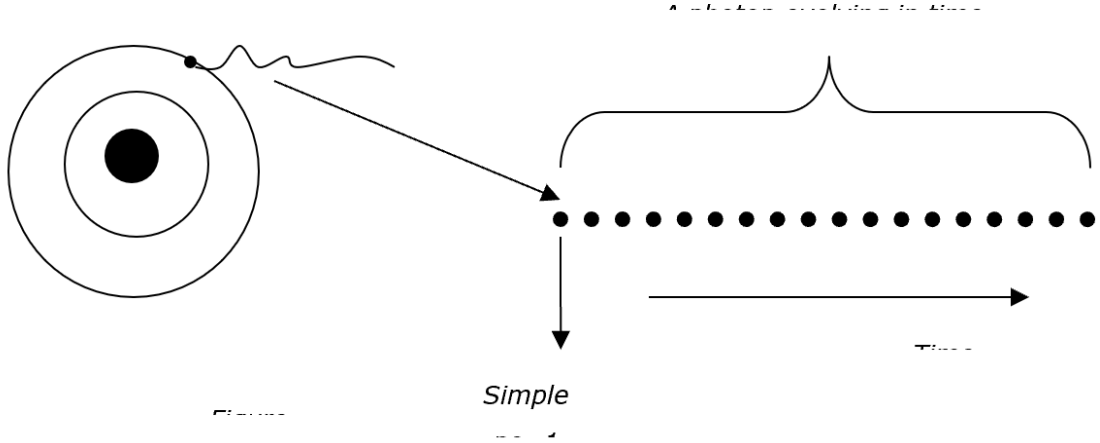

Figure 3.

If we assume that the photon is a quantum object in the sense discussed, it is composed of a set of simples evolving in time (see figure 3). The first simple of the set (of which only a few simples are pictured in figure 3), as I see it, if it is caused, has its cause from somewhere else than from the very set of simples. On this account, simple no. 1 of the photon has a cause that is not a part of the set of

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simples composing the photon. The phrasing 'has a cause' does not, of course, necessitate that there only *is* one cause of simple no. 1. On the causal composition account, simple no. 1 has only one cause, but that is not validated by the fact, as I see it, that its 'cause' does not belong to the set of simples composing the photon in question. If, on the other hand, the 'cause' of simple no. 1 was the only cause of simple no. 1, and if that cause did not cause *anything else* than simple no. 1, the conditions for the type of causality that is part of the notion of the strong thesis of causal composition would be fulfilled. The thing to be stressed here, however, is that the cause of simple no. 1 is not part of the set of simples composing the photon in question and therefore not part of the very simple no. 1. This leads to the question of where that cause, if it exists, is. For obvious reasons, that question is not to be looked upon in this philosophical context. What should be looked at, though, is the eventuality that the analysis is right – that the cause in question is somewhere else than in the very part in question. This is of utmost importance for the enterprise here to tie loop quantum gravity to the strong thesis of causal composition, since it opens up the subsequent question of where the cause is, if there is one, for the next simple in time following no. 1. It is easy indeed to imagine that that which exists, exists in the next quantum time unit of Planck time length just because it does exist; as if existence *per se* guaranteed existence in the next moment. [27] I challenge this by stating that there is a cause for the existence of *another* simple given that there is one in a particular quantum time unit. This amounts to the following argument:

P1 An evolving quantum object S is composed of a set of simples $\{s_1, s_2, ..., s_i\}$.

P2 Existence *per se* does not guarantee existence in the next tick of time: $\neg(s_n \rightarrow s_{n+1})$

P3 s_1 is not caused by itself, nor by $S = \{s_1, s_2, ..., s_i\}$ or by any subset of S. Therefore, the cause of s_1 is outside S.

P4 The cause of s_2 is either within S or not. As the second simple, its cause is either in itself, in s_1, or outside S.

P5 The causes of S have a minimal underlapper.

Now, if the cause of s_2 is within s_1, s_1 and s_2 do not have the same minimal underlapper, which they do have (P5), so s_2 is not within s_1. Also, the cause of s_2 is neither s_1 in itself (P2). Finally, due to P5, the cause of s_2 is not within itself. Therefore, the cause of s_2 is outside S.

Recursion can be used to ascertain that the rest of the object has its causes residing outside itself:

> Base case: s_1 is not caused by any simple of the set $\{s_1, s_2, ..., s_i\}$.
>
> Recursive case: If s_n is not caused by the set $\{s_1, s_2, ..., s_i\}$, then s_{n+1} is not caused by $\{s_1, s_2, ..., s_i\}$.

If we refer now to the causes of the emitted photon from a common source, we can assume they underlap it and that the conditions for the strong thesis are fulfilled. We have thereby tied one quantum object to the strong thesis. On this vision, then, we have a whole series of simples, each one caused, that has its total group of causes *outside* of itself. If we compare this with the situation for the organism, we, on one view, get a slightly different picture. If we were to suggest that the causes of the biological reactions were tied to the sphere of genetics, as in the genes of the organism, we again would have a situation where the first simple, the first biological reaction of an organism, might have its cause situated *outside* itself. If, on the other hand, the subsequent simples' causes were situated *within* the organism (in that case as some biological reactions themselves, *nota bene*), one would be hard pressed to explain all the simples as having a minimal causal underlapper. [28] To solve this, one could on the one hand add to the strong life definition a clause that somehow permitted the first simple to be part of the organism. On the other hand, perhaps more congenial, we could exclude that simple, in part on the grounds that it does not comply with the strong thesis, and in part on the grounds that just one biological reaction is just one biological reaction. If we took the other turn, we also *de facto* would have two simples in a row as the smallest possible organism (the one excluded and the one permitted).

Biological Wholes

Given that biological reactions are the parts of the organism, we can ask for the first simple of such (biological simples as conceived above).

Conclusion

The two causal composition theses suggested in this paper can account for the major answers that have been suggested in the literature to van Inwagen's Special Composition Question. The strong causal thesis has also been proven to block The Problem of the Many and vagueness objections to

causal style moderate answers to the Special Composition Question. Some support has been given to tie the strong thesis to science.

“as soon as something is assumed as a *quantum discretum*, the multiplicity of units in it is determined; hence it is always equal to a number”

(Kant, KrV, A 527/B 555.)

Footnotes

[1] This focus of the ‘activity’ of the xs in relation to the xs ‘composing life’ is “noticed by Justin Smith, because ‘in this model [of Leibniz], individuality and unity [of the organism] are defined through activity, not primarily through spatiotemporal cohesiveness’ (2011, 142).” (Huneman 2014, p. 163)

[2] Underlapping is defined as: x underlaps y iff there is a z that both x and y are parts of.

[3] Remember that U is the set of all parts as defined here.

[4] This is an ontological view defended by Horgan and Potrč (2000, abstract): “The ontological component, which we call 'ontological blobjectivism', makes two fundamental claims: (1) There really is just one concrete particular, viz., the whole universe (the '**blobject**'). (2) The **blobject** has enormous spatiotemporal structural complexity, and enormous local variability -- even though it does not have any genuine parts.”

[5] Or mother. The thing here is that it is the same parent.

[6] Part = df A coherent causal difference.

[7] $Cxy =_{df} \exists z$(*the cause of x belongs to z « the cause of y belongs to z).*

[8] Varzi (2014) uses this term in the following context: ”A stronger [compositional principle] condition would be to require that any pair of suitably related entities must have a minimal underlapper—something composed exactly of their parts and nothing else.” In the present context, the last condition is not used.

[9] I add the parenthetical disjunct “to secure the reflexivity of parthood,” as van Inwagen did and noted in Material Beings (1990, p. 288).

[10] *The binary predicate* ***C*** *can be used to form a kind of mereological sum that encompasses the object defined by the strong thesis. The sum is constructed in two steps. Given a specific part* p_o*, we can form a unary*

predicate $\mathbf{C}p_o$ *that identifies all the parts that are tied to* p_o *through the predicate* **C***. Definition: The unary predicate* $\mathbf{C}p_o(x)$ *holds if and only if (if x then* $\mathbf{C}(p_o,x)$*). This predicate holds for* p_o *and all those xs that have their causes related as given by* **C***, to* p_o*. Now the mereological sum of those xs that are* $\mathbf{C}p_o$*,* $\Sigma x\mathbf{C}p_o(x)$ *can be formed. This sum is a scheme for all parts* p_o*,* $p_{1,...}$ p_i*, and it encompasses the object that* p_o *is part of.*

[11] A definition of 'biological reaction' is not suggested here and perhaps better should be made within biology. The suggestion here is not 'what' they are but 'that' they are. Life, on this account, is not made of static things' activities but of dynamic things' activities.

[12] The Problem of the Many was launched in 1980 by Peter Unger.

[13] In 1990, he devoted the last section of his book to the problem of vagueness. The citation here is from his Précis of Material Beings.

[14] van Cleve states that "[t]he objection I am raising has been elaborated by Ted Sider (2001: 121-32)".

[15] Sider's/van Cleve's "there are cases in which composition occurs that are connected by a continuous series with cases in which composition does not occur", in my defence, is compared with van Inwagen's "the vagueness inherent in multigrade causal relations."

[16] Actually, of course, both are partitions with no intermediates.

[17] Atomless gunk is a concept of David Lewis: "Third, on a plaussible story about what non-fundamental entities there are, it will turn out that on Almost-Lewis's view, everything that exists is composed of simples (parts that themselves have no proper parts). Lewis is also agnostic on this score: he takes it to be at least an epistemic possibility that there is "gunk": something, every proper part of which itself has a proper part (see, for example, Lewis 1991)." (Hall 2012)

[18] As in the case if lifting my arm could be a biological reaction, then the very lifting would be composed of an amount of subparts.

[19] This is not to say that Markosian has this view in mind.

[20] Smolin (2008) "is partly based on the text of a talk given to a meeting of the British Association for the Philosophy of Science, in July 2004, under the title 'The relational idea in physics and cosmology.'" (p. 1)

[21] See Weinstein and Rickles (2014) for a review.

[22] See Hawley (2010) for a review of endurance and perdurance in relation to the notion of 'temporal parts'.

[23] Of Planck time length.

[24] Of cubic Planck length size.

[25] And other parts.

[26] In loop quantum gravity, networks of allowed quantum states (here named 'simples) are called 'spin networks'. On our chessboard, on this account, a spin network could consist of simples on a row. Smolin (2014, p. 96) describes how "[q]uantum spacetime corresponds to ... diagrams called spin foams, in which spin networks evolve over time."

[27] This touches upon the notion of 'law'. That existence per se yields existence in the next moment might be a law. If so, I argue that such a law should be accounted for on causal grounds.

[28] *This paragraph is inspired by (Huneman, 2014, p. 166-167)*

References

- Carmichael, Chad (2015). Toward a Commonsense Answer to the Special Composition Question. Australasian Journal of Philosophy.
- Hall, Ned, "David Lewis's Metaphysics", *The Stanford Encyclopedia of Philosophy* (Fall 2012 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/fall2012/entries/lewis-metaphysics/.
- Hawley, Katherine, "Temporal Parts", *The Stanford Encyclopedia of Philosophy* (Winter 2010 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/win2010/entries/temporal-parts/.
- Horgan, Terry & Potrč, Matjaž (2000). Blobjectivism and Indirect Correspondence. Facta Philosophica 2:249-270.
- Huneman, Philippe (2014). Kant vs. Leibniz in the Second Antinomy: Organisms Are Not Infinitely Subtle Machines. *Kant-Studien* 105 (2):155-195.
- Korman, Daniel Z., "Ordinary Objects", The Stanford Encyclopedia of Philosophy (Spring 2014 Edition), Edward N. Zalta (ed.), URL = < http://plato.stanford.edu/archives/spr2014/entries/ordinary-objects/>.

- Kuhlmann, Meinard, "Quantum Field Theory", *The Stanford Encyclopedia of Philosophy* (Spring 2014 Edition), Edward N. Zalta (ed.), URL = < http://plato.stanford.edu/archives/spr2014/entries/quantum-field-theory/>.
- Lewis, David (1991). Parts of Classes, Cambridge: Blackwell.
- Markosian, Ned (1998a). Brutal composition. Philosophical Studies 92 (3):211-249.
- Markosian, Ned (1998b). "Simples," Australasian Journal of Philosophy 76: pp. 213-226.
- Markosian, Ned (2014). A Spatial Approach to Mereology. In Shieva Keinschmidt (ed.), Mereology and Location. Oxford University Press.
- Noonan, Harold W. (1993). Constitution is identity. *Mind* 102 (405):133-146.
- Palmer, John, "Parmenides", *The Stanford Encyclopedia of Philosophy* (Summer 2012 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/sum2012/entries/parmenides/.
- Potrc, Matja (2002). Non-arbitrariness of composition and particularism. *Grazer Philosophische Studien* 63 (1):197-215.
- Sider, Theodore (2001). Four Dimensionalism: An Ontology of Persistence and Time. Oxford University Press.
- Smolin, Lee (2008), "The case for background independence," [Preprint at arXiv.org] http://arxiv.org/pdf/hep-th/0507235v1.pdf
- Smolin, Lee (2014) Atoms of Space and Time. Scientific American (November 2014), 23, 94-103 Published online: 23 October 2014 | doi:10.1038/scientificamericantime1114-94
- Sider, Theodore (1993). Van Inwagen and the Possibility of Gunk. *Analysis* 53 (4):285 - 289.
- Smith J. E. (2011) Divine Machines: Leibniz and the sciences of life. Princeton.
- Thomasson, Amie L. (2007). Ordinary Objects. Oxford University Press. DOI:10.1093/acprof:oso/9780195319910.003.0008
- Unger, Peter (1980). The Problem of the Many. Midwest Studies in Philosophy 5 (1):411-468.
- van Cleve, James (2008). The moon and sixpence: a defense of mereological universalism. In Theodore Sider, John Hawthorne & Dean W. Zimmerman (eds.), Contemporary Debates in Metaphysics. Blackwell Pub.
- van Inwagen, Peter (1987). When Are Objects Parts? *Philosophical Perspectives*, Vol. 1, Metaphysics, pp. 21-47
- _____. (1990). Material Beings. Cornell University Press.
- _____. (1993a). Précis of Material Beings. Philosophy and Phenomenological Research. 53 (3):683 - 686

- _____. (1993b). Reply to Reviewers. Philosophy and Phenomenological Research 53 (3):709 - 719.
- Varzi, Achille (2014). "Mereology", *The Stanford Encyclopedia of Philosophy* (Fall 2014 Edition), Edward N. Zalta (ed.), URL = http://plato.stanford.edu/archives/fall2014/entries/mereology/.
- Wasserman, Ryan (2002). The standard objection to the standard account. *Philosophical Studies* 111 (3):197 - 216.
- Weinstein, Steven and Rickles, Dean, "Quantum Gravity", *The Stanford Encyclopedia of Philosophy* (Winter 2014 Edition), Edward N. Zalta (ed.), forthcoming URL = http://plato.stanford.edu/archives/win2014/entries/quantum-gravity/.

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