Can Quantum Field Theory help address the Subject Summing Problem?

T. Peterken

E-mail: tobypeterken@gmail.com

Abstract:

The subject summing problem poses a major challenge for panpsychist theories of consciousness: it seems implausible that the micro-subjective experiences of the billions of particles in a human brain could combine to form a single unified conscious subject. This paper explores the impact of Quantum Field Theory (QFT) on several proposed solutions to this problem. Specifically, I argue that QFT challenges the standard conception of everyday objects, from molecules to chairs to individual people, as mere aggregates of subatomic particles. Instead, objects associated with bound states or resonances are better conceived as unified entities.

The implications of this claim for the subject summing problem depend on one's preferred ontology for QFT: a particle ontology resembles Combinatorial Infusion approaches, while a field ontology parallels cosmopsychism. Both connections are explored in turn. Additionally, QFT suggests a new version of the combination problem: since bound states are ubiquitous, everyday interactions may frequently produce unified physical objects without an apparent merging of conscious experience.

While this work is not intended to be conclusive, it highlights the importance of integrating fundamental physics into metaphysical discussions of consciousness.

Contents

1 Introduction

One of the most challenging problems in the philosophy of mind - aptly referred to as the hard problem of consciousness - is the how physical process in the brain could give to phenomenal consciousness [1]. There are a range of proposed solutions to this problem, as can be found in [2, 3], and one solution that seems to be gaining in popularity is Panpsychism.

Panpsychism (or specifically Panpsychist Russellian Monism) is the theory that phenomenal consciousness (hereafter just referred to as consciousness) is a common and fundamental feature of nature [4–7]. There are a wide range of theories that fall under this banner; however, a general characterization of these theories that is sufficient for now is the following. The fundamental physical constituents of the universe, such as quarks and electrons have, supposedly simple, phenomenal properties and our complex conscious experience is in some way caused by or grounded in the microphenomenal properties of the fundamental physical constituents that make us up.

A major problem facing panpsychism is the combination problem [4, 6, 8]. This takes several forms, but for this work I will focus on the *subject summing problem*. The brain is made from trillions of individual particles, each with their own phenomenal consciousness and yet, when they combine into a brain, there is only a single unified conscious experience. In a similar manner to to Chalmers' conceivability argument against materialism, one can imagine a person entirely identical with you, with every physical and microphenomenal property kept the same (that is, the physical and experiential properties of every individual particle is the smae), without it instantiating your

full unified experience. If this problem remains intractable, panpsychism fails to have any unique explanatory power over materialism.

Panpsychism makes claims about microphysical objects and their (phenomenal) properties; even though it is not necessary that microphenomenal and microphysical behaviour mirror each other entirely, it would be remarkable if they were not in some way parsimonious. At the very least, we cannot neglect fundamental physics when trying to understand the fundamental microphenomenal constituents of the universe. In reference to the subject summing problem, we need to understand how microphysical entities interact and combine to create larger composite objects.

Currently, the most fundamental physical theory describing these interactions is the Standard Model [9–11], which is a specific example of a quantum field theory (QFT). In this work, we therefore consider the nature of compositeness in QFT and its implications for the subject summing problem.

The outline of this paper is as follows. In sec.2 we consider the nature of compositeness in QFT, independently of considerations from philosophy of mind. In sec.3 we directly relate these considerations to different solutions to the subject summing problem. Exactly how QFT affects the subject summing problem depends on if one prefers a particle or field ontology and we therefore discuss each in turn. In sec.4 we discuss how, in QFT, it is plausible that many everyday situations result in fundamentally new objects and the effects this has on the subject summing problem. Finally we conclude the discussion

The aim of this paper is not to be comprehensive or give conclusive support to a particular solution to the subject summing prblem, but to emphasise the importance of QFT in the discussion and highlight the similarities between different interpretations of QFT and different proposed solutions to the problem.

2 Compositeness within QFT

A conventional description of the standard model is that there are a range of different fundamental particles, such as quarks and leptons which make up the matter we see around us. These then interact by exchanging particles such as the gluon or photon. In some cases - such as for the quarks in a proton - the gluon being exchanged causes a force of attracttion, and the quarks stay held together, and the resulting aggregate is called a proton. In this description, there is a heirarchy of composite particles, quarks are fundamental and come together to compose protons and neutrons, protons, neutrons and electrons come together to compose atoms, and atoms come together to compose macroscopic everyday objects.

In previous work, I have argued against this hierarchical conception of compositeness [12], arguing that the mathematical framework of QFT (and a fortiori the standard model) provides no criterion to form this hierarchy. Instead, any object or configuration of matter that is associated with what is known as an S-matrix pole is equally fundamental. I will justify shortly that this includes many everyday objects, however, the question of whether a particular (macrosopic) configuration of matter is actually associated with an S-matrix pole would need to be explicitly verified; this is an active area of research [13, 14] and as far as I am aware, no one has yet explicitly verified the existence of an S-matrix pole for anything bigger than an atomic nucleus or small molecule. That being said, there is no reason to think that QFT has an upper limit: in principle, fundmanetal physics should describe macrosopic phenomena just as well as microsopic phenomena.

Physically, S-matrix poles occur in situations where there are attractive forces holding everything together (more correctly, they occur around local energy minima or in potential wells [15, 16][1]). This means, any object which is in someway stuck together, is associated with an S-matrix pole, and the resulting object is not composite - not a mere aggregate of smaller particles - but is equally fundamental to the electron and quarks that are traditionally considered to compose it.

With this picture, when two atoms come together to form a molecule, the atoms cease to exist as individuals and now a molecule exists in their place: a molecule intelligibly emerges from the interactions of the precursive atoms. Similarly, at the macroscopic scale, when you screw an Ikea chair leg into the seat, the seat and chair leg cease to exist as individuals and a fully made chair exists in their place, again the completed chair emerges intelligibly from the interaction of the seat and chair leg.

In other words, this implies that a large class of everyday objects are genuine unities, and not mere aggregates of the particles that make them up. The reason they still appear to be mere aggregates is that if the interactions are relatively weak (such that the binding energy of the bound state is much less than the rest mass energy), the bound state appears to be almost - but not quite - identical to the aggegate.

The rest of this section provides some non-technical justifications for this proposed ontology, however these will not be necessary for the rest of the paper. Full details can be found in [12].

2.1 Justification from scattering

The properties of particles are deduced via scattering experiments, such as what occurs at the Large Hadron Collider, and the outcome of these experiments can be determined mathematically via an S-matrix. The mathematical procedure to do this relates incoming configurations to outgoing configurations (formally, these are defined in the infinite past and future), but not to intermediary configurations. All the information one can directly deduce from an S-matrix or scattering experiment is the probability of a process happening. That is one can work out the answers to questions such as "how likely is it that the pion decays into two photons" and "if two photons come together, what is the chance of them becoming a pion?" but not "is the pion made of two photons?". [2]

2.2 Justification from arbitrariness

When calculating any process or quantity in QFT, such as the mass of a proton, one has to take into account contributions from all the different particles. It would be tempting to interpret these contributions as giving information about the constituents of the proton: if there is a contribution from the top quark field, then the proton contains a (virtual) top-quark.

The issue with any such interpretation is that any calculation within QFT requires several choices to be made, such as renormalisation scheme, gauge fixing and the basis of the Hamiltonian. Many of these choices are arbitrary (albeit some are more useful than others) and they effect the relative contributions from the different fields to the process in question. Therefore, any attempt to interpret

[1] These references are discussing non-relativistic quantum mechanics, not QFT, however scattering theory is similar enough in both that the intuition we gain from non-relativistic quantum mechanics should be sufficient.

[2] At the level of argument given here I have not shown that the S-matrix does not give additional, albeit non-observable, information that could be used to deuce the composition of particles.

the details of a calculation will give a different physical picture, depending on what choices get made in a calculation. In order for the question of whether or not a proton contains a top quark to have any significance, the answer must not depend on arbitrary choices; but that is what we find.

This goes further, even when calculating the properties of obstensibly fundamental particles such as the electron, there are contributions from other fields. If this were interpreted physically, then the (supposedly fundamental) electron would be composed of all the other particles, which would in turn be partly composed of electrons. This infinite tower of composition is clearly paradoxical.

3 Relation to the subject summing problem

As argued in the previous section, many macroscopic objects - including individual people - are not composite objects, but are equally fundamental to the particles that are usually considered to make them up. If a person is a single entity, and not a mere aggregate of smaller particles, then it is less surprising that they have a single unified conscious experience.

Exactly how QFT considerations impact the plausibility of any proposed solution to the subject summing problem [4] depends on which ontology of QFT one prefers: particles or fields[3]. A summary of the different ontologies can be found in [11, 17, 18] and for now I will remain agnostic on the question of whether a field or a particle ontology is a better description of QFT - although it does seem that a field ontology has wider support [19].

In the following, I briefly outline these two ontologies for QFT and explicitly relate each one to proposed responses to the subject summing problem. I will not argue against or in favour of any particular solution or ontology, but merely highlight similarities.

3.1 Particles and Combinatorial Infusion

In a particle ontology of QFT, the fundamental entities the theory describes are particles. The notion of a particle here differs from that of a classical particle. For what follows, I will take particles to be discrete objects, with certain fixed properties such as mass and charge, and each with a finite number of degrees of freedom[4]; more details on the conception of particles within QFT can be found in [11, 17–19].

In light of the argument made in Sec. 2, this ontology would imply a wide range of objects are actually fundamental particles. When particles combine, the initial constituents cease to exist are replaced by the new particle. Even though the new particle is a new entity, its existence and properties are completely derivable from the behaviour of the initial constituents and hence there is no strong emergence going on.

This sort of composition is analogous to the *Combinatorial Infusion* proposed by Seager [21, 22] and Morch [7]. Under this view, when subjects combine they undergo a form of Combinatorial Infusion, where the previous subjects are replaced by a new subject in such a way that even though the new subject is a completely new entity, its macro-phenomenal properties are intelligibly caused by the micro-phenomenal properties of the initial subjects.

[3] There are other, so called non-calssical, ontologies, but these are beyond the scope of this article.

[4] Since we no longer have some key properties of classical particles such as primitive thisness or indiscernability, some may want to refer to what I call particles as 'quanta' [20].

In the original papers, Seager uses examples from physics to show how this sort of Combinatorial Infusion law might work. However, these are only used to show that such a law is coherent, and would not be radically emergent. He goes on to suggest that "there is little evidence that the brain supports any processes that could count as Combinatorial Infusion at the physical level" [21, p15], which could count as a serious challenge against Combinatorial Infusion. However, as said above, the brain (or rather the whole person) would count as a single fundamental particle; so QFT does indeed suggest that the desired kind of Combinatorial Infusion is occurring at the physical level.

3.2 Fields and cosmopsychism

In opposition to the notion of a particle, a field has degrees of freedom associated with each point in spacetime, leading to an infinite number of degrees of freedom. A field ontology for QFT proposes that the fundamental physical object is a field that permiates the entire universe. Particles are not separate entities but are (weakly) emergent phenomena of the field; very roughly, particles are particular forms of waves in the field. Facts about electrons, atoms, chairs and so on are grounded in facts about the field. In light of the argument in sec. 2, facts about the field ground the facts about macroscopic objects like chairs directly and irreducibly, it is not the case that the grounding relation can be reduced into several stages where the field firstly grounds fundamental particles like electrons and quarks, which in turn ground atoms, which in turn ground chairs.

Analogously, cosmopsychism is the view that the most fundamental entity is the universe as a whole, and that the universe is conscious. Facts about other material entities are grounded in facts about the universe; in particular, facts about ordinary conscious subjects are grounded in facts about the consciousness of the universe [5] [6, 24–26][6].

Although the language used is different, both a field ontology and cosmopsychism propose a fundamental entity that fills the entire universe and grounds physical objects and phenomenal experience respectively.

Without the claim of sec. 2, our brains would be composite objects, facts about the brain would be reducible to facts about the particles that make it up. If this were the case, cosmospsychism would have the inelegant (although by no means fatal) consequence that when grounding a person, their conscious experience must be grounded directly and irreducibly as a unified whole (see chapter 8 of [6] for arguments for the irreducibility of subjects), whereas, the matter in their body could be grounded indirectly and reducibly, with the fundamental field firstly grounding fundamental particles, and then these atoms acting as the ground for the physical body itself.

However, as the physical body is not a composite object and is instead a unified whole, just like the conscious experience of the person whose body it is, there is no such mismatch to worry about. Both the physical body and the phenomenal subject are both grounded directly by the fundamental universe wide conscious field.

[5] In [23], Goff proposes a form of cosmopsychism where the existence of subjects are not grounded in but are instead strongly emergent.

[6] Of these, the framing in [24] is most explicit.

4 A new combination problem

Both Combinatorial Infusion and Cosmopsychism get at least some support from the fact that they purport to help resolve the subject summing problem. There are of course philsophical issues with both responses, which I will not go into here.

However, the discussion of compositeness above does raise a new concern, no matter which ontology of QFT (or therefore no matter which solution to the subject summing problem) one considers. I have implicitly assumed a close correspondance between those particles associated with an S-matrix pole and subjects of phenomenal experience. That is, I have assumed that the fact that my body corresponds to a single physical object (partly) explains the fact that it is a singular subject of conscious experience.

To see that this raises a new issue, consider the situation of two people holding hands. Before they hold hands, each person is a single subject and are each associated with an S-matrix pole. However, after holding hands, the two people are in physically joined together meaning that the resulting configuration is (plausibly) associated with an S-matrix pole. Thues, when two people hold hands, a new singular object emerges without forming a singular subject.

This raises the question of the nature of the correspondence between S-matrix poles and subjects. One option is that each subject is associated with a pole, in which case two people holding hands would form a singular subject. Alternatively, there is no direct correspondence between subjects and S-matrix poles, in which case one has to explain how a single object, with no parts, can give rise to two separate subjects[7].

5 Conclusion

Quantum field theory gives a different account of physical phenomena to other physical theories, even when compared to non-relativistic quantum mechanics, and therefore imposes new considerations onto metaphysical questions. The details of this imposition depend on how one interprets QFT, but there is an imposition nontheless.

One such consideration is the nature of compositeness. Within QFT, any object associated with an S-matrix pole is equally fundamental, meaning wide range of everyday configurations which would normally be considered mere aggregates are actually single objects.

QFT also imposes itself onto Russellian panpsychism in two ways. Firstly, if consciousness is part of what ultimately grounds fundamental physical entities, then any explanation of consciousness must be compatible with our most fundmental physical theory. Additionally, a major objection to panpsychism is the combination problem, this problem is related to how objects - both physical and phenomenal - combine and aggregate. Although QFT does not solve this problem, the account of compisiteness it entails surely cannot be ignored when considering any proposed solutions.

Finally, we see that this raises a new form of the combination problem. The nature of compositeness implied by QFT provides many situations where two people may become physically joined and associated with a single S-matrix pole. In this case we need to explain how both people retain their individual identities.

[7] Chalmers [1] argues the physical correllate of consciousness is actually information, in which case there is no reason for there to be a connection between consciousness and the existence of objects.

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