4-1-2010

Philosophical Issues in Cosmology, Quantum Theory, and Time

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Original Citation

Comments on Alyssa Ney's paper "Quantum Mechanics and Three-dimensional Space." Philosophical Issues in Cosmology, Quantum Theory, and Time Conference. Rutgers Center for Philosophy and the Sciences and the Philosophy Department, New Brunswick, NJ. April 16-18, 2010.

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Comments on Alyssa Ney's "The Status of Ordinary Three-Dimensional Space in Realist Quantum Mechanics"

Alyssa's paper discusses the success of various possible ontologies for quantum mechanics in explaining certain features of our manifest image, given the scientific image of quantum theory. In particular, she focuses on the success in explaining the perception of the three-dimensionality of space. There are two main ontological alternatives: the wave function ontology, and the primitive ontology. According to the former, everything there is is described by the wave function in configuration space; the latter instead claims that matter is described by some other entity in three-dimensional space or in four-dimensional space-time. Alyssa argues that, for different reasons, both alternatives fail in providing a satisfactory explanations of our manifest image. I respectfully disagree. In order to explain why, let me go through her arguments one after the other.

There are four arguments in her paper: the first is an argument for the indispensability of the wave function based on entangled states. Very roughly, the idea is that the only way of explaining the existence of entangled states is to postulate the existence of the wave function. Alyssa thinks this argument is establishing that we cannot really say that there is no wave function. I think that there is a sense in which is true, and one in which is not. It is not true that the wave necessarily has to describe physical objects, while I think it is true in the sense that there has to be some object in the theory that will be able to account for such states. The argument is based on the premise that there are entangled states, **and** that these states describe physical stuff. But that is not necessarily the case. The entangled states are states about the wave function: it is the wave function that is in superposition. So, only if one is wave function realist entangled states are states of matter, while the primitive ontology (representing matter) is never in superposition. That is, observing that there are entangled states only shows that there has to something in the theory that accounts for them (Ψ), but that does not necessarily mean that this object has to represent physical reality: indeed, this is exactly what the primitive ontologists are denying. This is their way to solve the measurement problem. In fact, consider Bohmian mechanics: the wave function is in death-life superposition, but the cat is made of particles, and it is never both dead and alive. Her particles are either in the support of the "dead" wave function or in the "live" one, and it is very unlikely that if they are in the dead sector their position will move back in the alive one. So, to sum up, the argument form entangled states does not prove the wave function has to "physically" exist. Be that as it may, Alyssa continues: if the wave function exists, it lives in a very high dimensional state (configuration state). As such, she says, the configuration space should not really be called that way, since configurations suggests that there are particles, and this is not true. And the problem here is that alone configuration space has no resources to recover three—dimensional space for the wave function realist. I think there is not much controversy here: this has been already pointed out by many people,not only by opponents of wave function realists like myself, Nino, Shelly, and Tim, but also by the very proponents of wave function realism like David and Barry themselves (that is why David introduces the Hamiltonia rule).

So the next step Alyssa take is to analyze the possible options, the first being the one based on primitive ontology. She finds the view unsatisfactory in the characterization ("what are you talking about?") and

in the motivation (“why go that way?”) . I will try to make a little bit of clarity here.
Indeed, there has been a lot of problems in the understanding what this view says because of the locution”primitive”. I do not think one should be confused by language, so for the moment let us forget for a moment this name, and let us try to understand what the view really say (or at least this is how I see it) regardless on how one decoded to call things.
The main idea is that the wave function does not represent matter, some other object in 3-dimensional space does. The reason why the wave function does not represent matter is simply that it does not live in the “right” space. The “right” space here means the space of the manifest image: we all believe that physical space is 3-dimensional, and this is exactly what we should continue to believe. Why? Because it worked for us in the past (see other fundamental physical theories), and there is no reason why we cannot do it also here. There is nothing that forces us to accept the wave function as composing matter (as I was explaining earlier discussing Alyssa's first argument). Indeed, if we do insist in considering the wave function as representing material objects then we have the problem of “recovering” 3-dimensional space. If instead we start from a scientific image based on 3-dimensional objects, then we have no problem whatsoever (at least we have no additional difficulties than the difficulties that we might have in classical mechanics) in recovering the manifest image.
Alyssa thinks that this view is “less straightforward” in the sense that originally in quantum mechanics we just had Schroedinger's equation that is about the wave function, and this is the main reason why we should think the theory is about the wave function. I don't think that is true: even if that what is was originally, the measurement problem suggested that we should revise that idea. In fact if we insist in claiming that the wave function represents matter, we have the dead and alive cat, and we would have to struggle to reconcile the manifest with the scientific image. So which one of the two is more straightforward? Assume that all there is is wave function and come up with some complicated theory to account for the manifest image, or realize that the wave function does not constitute matter, something else does, and continue using the same reductionist machinery we used already in classical mechanics? Which one is more scientifically conservative?
In other words then, for the primitive ontologists there is nothing to reconcile between the scientific and the manifest image at the level of fundamental space, there is no recovery of three-dimensional space since this is right there from the beginning as the fundamental space of the theory. The explanation that the theory provides is far more direct and transparent than the one provided by the wave function realist. This seems to be a very good to me to depart from what Alyssa calls the “most straightforward reading” of quantum mechanics, a reading that I would call, using Rodi's terminology, “the most romantic reading” of quantum mechanics.
This is what I have to say about motivation. I have said already something about the characterization, but I did not actually finish: the status of the wave function in the theory remained a little mysterious. And therefore now I cannot avoid talking about the primitive-nonprimitive distinction. We primitive ontologists are not saying that the wave function does not exists. It does, but it is not primitive. That means that the wave function does not represent physical stuff, but it is part of the theory nonetheless, it is the nomological component, it is what tells mater how to move. So, it is not primitive in the sense that it is not representing objects, while it is governing their behavior: it would not make such sense to talk about the wave function alone if not in terms of particles. As such, it could be considered similar to a law of nature. This claim is also perceived as mysterious: how can the wave function be a law of nature if it is time dependent? This objection has been raised by many people (David Wallace, Peter Lewis) and it has already been replied: Detlef, Nino and Shelly have a paper (“BM and the meaning of the wave function”) and there is another one by Stefan Teufel and Shelly (“Quantum Spacetime without Observers: Ontological Clarity and the Conceptual Foundations of Quantum Gravity”) in which they

explain how the time-dependent Schroedinger equation can phenomenologically emerge from a future theory of quantum cosmology in which the wave function is stationary, i.e. it is time independent. So ti seems like the time-dependency of psi is just a contingent matter, resting on the provisional nature of quantum mechanics: while we will arrive to a more complete a satisfactory theory as quantum cosmology we would not be having a time-dependent wave function any longer.

Judging our projects unsatisfactory, Alyssa starts analyzing the project of the rival wave function ontology view. As is clear, their main task is to "recover" the manifest image, and the claim of the proponents is that they can do it being functionalists with respect to properties. Alyssa raises doubts regarding the possibility of doing the same for space: if I understand her correctly, she says that if one is a substantivalist with respect to space, this cannot work since functionally enacted space is just a simulation. That is a very interesting consideration: if the fundamental space is R3N, it is not R3, period, no matter you play with words, and any recovery of R3 will be just be illusory. Now, I wonder how much this objection will impress the wave function realists: I think that David and Berry will be just as happy with this as they were before: after all, they have already accepted that R3 is an illusion to start with, and now, with their functionalist machinery, they have explain why we have this illusion, so there is no surprise for them.

In any case, I think I have talked too much already, so I will thank Alyssa for the wonderful paper and I will let the discussion begin!