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Metaphysics Meets Physics on the Banks of the Raritan

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Comments on Cian's Dorr's paper "Our Place in a Quantum World"

Cian's new quantum theory

Let us start with a summary of what I take to be the main thesis of the paper. Consider the following world, called the Schrödinger world, in which the following things are real: Configuration space time points, space time points, and the wave function, that evolves according to Schrödinger equation without exception.

The thesis seems to me to be the following: it is possible to describe (what we usually think of) ordinary objects in a world like the one just described. In explaining how it is possible he is providing a new quantum theory, different from the ones people have put forward so far.

In what sense it is different?

We just saw what the ingredients of the theory are. But another thing is being mentioned. Considerations about persistence thought time of ordinary objects (and people) bring him to think that we need to have some natural way to identify objects through time even in situations in which we have a spread-out or superposition wave function. That is, some sort of natural way of carving up configuration space so that we have a unique "natural flow" in configuration space with which we can identify the object(s) as "persisting" through time. This natural and unique way of doing this, he says, is the Bohmian velocity field. But it is important to notice that he argues that this is a naturally emergent law, and therefore as such it is not some additional postulate of the theory.

Similarities and differences

Three-dimensional space

His theory seems really similar to the many-worlds theory in the sense that it assigns reality to all "bumps" of a superposition wave function. But it differs from the many-worlds theory in at least one respect. All there is in the many-worlds theory, at least according to most proponents of this theory, is the wave function and configuration space. Many-worlds theorists would deny the necessity of adding three-dimensional space to the furniture of reality. While according to Cian we also need to have (three-dimensional) space-time.

But what is the reason why he wants to add it to the furniture of reality?

Cian argues that having just configuration space without any additional structure is insufficient for his project. In fact, one of the things we would want ordinary objects to have is a definite location in space-time. And unless we postulate the existence of a fundamental space-time it seems difficult to see how this would come about.

I think that he is right and wrong at the same time here. On one hand, I think he is right in saying that the wave function as such does not have enough structure to read off from it three-dimensional space unless one assumes three- dimensional space is already there. Of course, calling the abstract M dimensional space (that just happens to be such that M=3N) "configuration space" is suggesting that indeed it is constructed from the configurations of N things in three-dimensional space. But if we postulate, in contrast, that configuration space is fundamental and that there is no three-dimensional space, just calling the M=3N-space configuration space will not help in making its coordinates configuration of anything. On the other hand what I just said works only if you have "stuff" in three-dimensional space and it is unclear whether he has it.

Be that as it may, Cian thinks that a way to take care of that worry is to postulate a three-

dimensional space along c-space and have some correspondence relation between the two.

I wish to notice here that this is not the only possibility. In fact this approach should be contrasted with the position of David Albert concerning theories like GRW. David would say that it is possible to read off tables and chairs (as we usually think of them) directly from the wave function alone in configuration space, without adding any additional three-dimensional structure. Indeed he thinks that three-dimensional space *emerges* naturally from the structure of the Hamiltonian: you can explain the fact that the world seems to us three dimensional with the fact that Hamiltonian is what it is.

I tend to share Cian's intuition in this respect that the right thing to do is to stipulate the existence of three-dimensional space rather than saying that three-dimensional space "emerges from" configuration space. My intuition differs from one of Cian in the fact that I do not think you have reasons to think you need or should to postulate configuration space to be fundamental.

(A parenthetical remark: Of course one obvious difference between David's GRW and Cian's theory is that the world would not be a Schrödinger world because the wave function would evolve according to an equation which is different from Schrödinger's one. But I do not see how that would matter: here we have spread out wave functions, with, say, two bumps, and even if one bump is much smaller than the other because of the spontaneous collapse dynamics, a small bump is still a bump, and whatever problem in identifying objects you had before you will also have here.)

I think my purpose here and now is to stimulate the discussion, so I think this is one of the questions we should address: can three-dimensional space emerge from configuration space?

Cian's answer seems to be NO (otherwise, why postulate three-dimensional space?). But if it is the case, then, the position that he holds is somewhat at odds with the position that he holds later on. I will come back to this in a second.

Personal Identity and the v-field

Cian's theory is also different from the many worlds theory as far as what objects through time are: in many worlds every time we have a superposition we will have to have some sort of fission, and this is something that Cian wants to avoid. Therefore he wants to find a perfectly natural partition of configuration space that would allow us to say: "yes, this is me all along".

He thinks that this perfectly natural partition is provided by the Bohmian velocity field, and because of its naturalness he wants to say that it is NOT an additional postulate but rather it is an emergent law, something that was in the wave function all along and that just jumps out to us without any need of postulating something additional.

The theory then is similar to Bohmian mechanics in the sense that objects follow a velocity field given by Bohm's guide equation. But it differs from the Bohmian approach in that Bohmian like me would not say that the fundamental space is configuration space. I would rather say that the fundamental space is three-dimensional space and that the field that governs the behavior of particles in three-dimensional space is non-local. So in Bohmian mechanics as I see it there is just one trajectory in configuration space-time and it is just a representation of what happens to three-dimensional things in three-dimensional space. This also differs from what David Albert would say about Bohmian mechanics: in his view we have one particle and one field (the wave function) in configuration space. Period. In Cian's view instead there are no particles (neither in three-dimensional space nor in configuration space), there are plenty of trajectories in configuration space-time (the "Bohmian threads"), each of them representing a "world" with objects in them, and the different world will be "transparent" with one another.

Now, I have trouble seeing why on one hand Cian is saying that three-dimensional space could not emerge while the velocity field not only could but would. If one is willing to accept that things can emerge from others when certain conditions are satisfied (like, for example, the v-field is natural), then what's wrong with David's argument of the Hamiltonian? Why isn't that natural in a similar way?

I can imagine people arguing that both can emerge, and I can imagine people arguing that none

of them does (I am actually one of them) but I would like to hear more about what's different here between the v-field and the dimensionality that justifies treating them differently, allowing for the possibility that one can emerge while the other cannot.

Motivation

This is another thought, connected with the motivation of the whole project. This theory seems to be a sort of merging between many worlds and Bohm. The natural question therefore is: why do we want or need such a theory?

One good reason to look to a theory like this could be provided by the fact that both the Many-Worlds theory and Bohmian mechanics do not work in some important respect while this one does.

Let me see whether it is the case. One could complain about Many-Worlds theory because of concerns of personal identity, and this is why Cian wants to add (in this very loose sense of add) the velocity field. That might be a good reason to reject Many-Worlds. But why should I prefer this theory to Bohm?

One way to respond could be the following: what Bohmian mechanics is doing is adding (literally) particles in three-dimensional space to the ontology of Cian's theory. If that is the case, and if Cian's theory works, then it seems that there is no need of the Bohmian particles, they just add additional structure that is not doing any work, so why add them? The problem is that I would disagree with that characterization of Bohmian mechanics: what Bohmian mechanics does is postulate the existence of particles moving around in 3-space, while configuration space is just auxiliary. If it is described like that, Bohmian mechanics is much simpler that Cian's theory. So why should I go with his?

Indeed one of the problems that I see in that theory, as in any other theory whose fundamental space is configuration space is the following: if there are Bohmian threads, each of them will be a world, therefore each one of them will contain lots and lots of objects. But how am I going to tell the various objects in the single thread apart? How am I going to explain that if I drop this pen it will going to fall down as if the laws of classical mechanics were true? One way to do this would be to say that there are particles in three-dimensional space, namely that those particles compose physical objects and indeed one can show that, under suitable circumstances they will behave classically. But Cian does not want to have particles in three-dimensional space. So, as far as I am concerned, there is a huge gap to be filled here. I am not saying that it cannot be filled; I am simply saying that it hasn't.

To conclude and summarize, I will say the following: Cian's theory either will succeed in accounting for ordinary objects or will not. If it will succeed, then it seems to do so because of the same reasons why a theory in which there is just configuration space time and no three-space could succeed: “things just emerge”. But if objects can emerge from configuration space with all their features including three-dimensionality, then there seems to be no reason to add three-dimensional space. But if so, the stuff he adds just seems redundant and the Bohmian threads, being just emergent and not fundamental, cannot help here: his theory is at best one (more “populated”) version of Many-Worlds. So why prefer Cian's theory to the usual Many-Worlds view?

On the other hand, if the program will not succeed, that seems to happen because of its postulation of configuration space as fundamental. That is, if it will not succeed it is because one of the arguments according to which ordinary object cannot emerge from configuration space works. And if they work, then it is over anyway, and I do not see how using the emergent, not fundamental Bohmian threads could help here.

Things would change a bit if he would add them to the fundamental furniture of the world, but not much better: in that case, his theory would be clearly different from MW and closer to BM.

In that case his theory would be a sort of “overpopulation” version of BM. But again, considerations about simplicity and economy would tell us to go with Bohm and not with him.