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Free Will in a Quantum World?

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Abstract
In this paper, I argue that Conway and Kochen's Free Will Theorem (Conway and Kochen 2006, 2009) to the conclusion that quantum mechanics and relativity entail freedom for the particles, does not change the situation in favor of a libertarian position as they would like. In fact, the theorem more or less implicitly assumes that people are free, and thus it begs the question. Moreover, it does not prove neither that if people are free, so are particles, nor that the property people possess when they are said to be free is the same as the one particles possess when they are claimed to be free. I then analyze the Free State Theorem (Conway and Kochen 2009), which generalizes the Free Will Theorem without the assumption that people are free, and I show that it does not prove anything about free will, since the notion of freedom for particles is either inconsistent, or it does not concern our common understanding of freedom. In both cases, the Free Will Theorem and the Free State Theorem do not provide any enlightenment on the constraints physics can pose on free will.

Keywords: Free Will Theorem, Strong Free Will Theorem, Free State Theorem, Nonlocality, Compatibilist Free Will, Libertarian Free Will, Free Will, Quantum Mechanics.

1. Introduction

The debate over free will and the development of physics are intertwined. Newtonian mechanics, the prototypical deterministic theory[2], is in tension with free will: the laws of nature control us as the puppet master controls the puppet. Some have resorted to the indeterminism of quantum mechanics. However, free will is different from randomness, so it is also incompatible with indeterminism.[3] Nevertheless, recently John Conway and Simon Kochen (Conway and Kochen 2006, 2009) have proven a theorem, which they

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[2] Some have questioned the extent to which Newtonian mechanics is deterministic. See, for instance, Earman (1986) and Norton (2008). However, for the purpose of this paper we can ignore these subtleties since we are concerned with quantum mechanics.

[3] See, for instance, Searle (1984), Strawson (1986), Pinker (1997), Clarke (2003), Balaguer (2004), Kane (1996). The basic idea is that laws, deterministic or stochastic, are still 'in charge' of future actions, we never are: if we are string puppets, the fact that sometimes the strings may jerk randomly does not change the fact that we do not decides how we move.

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call the Free Will Theorem, to the conclusion that quantum mechanics, no matter whether deterministic or stochastic, together with relativity not only are compatible with free will but, in some sense, also entails it.[4]

The theorem has received a lot of attention by the physical community and by a more popular audience[5], but has not been discussed much within the philosophical community, especially libertarians, even if Conway and Kochen themselves encourage the philosophers to have a look to their result.[6] Others have previously attempted the similar task of connecting free will with quantum mechanics[7] and people have already responded to them.[8] However, this time the result looks less speculative: a theorem, if sound, is more than compelling evidence of the existence of a libertarian free will. Moreover, this theorem, if sound, follows directly from the quantum formalism and from the theory of relativity, without further speculations. As such, it seems to have broader implications than, for instance, Henry Stapp’s theory of free will (1991, 1993, 1995, 1997, 2017), which relies on a particular interpretation of quantum mechanics in which the mind is collapsing the wave function. Anyway, there may be various reasons why metaphysicians may not have engaged with this result. One could be that often arguments from quantum mechanics are inconclusive, given the controversial nature of the theory.[9] Another, that the paper is too technical. Be that as it may, in this paper I aim to analyze what the theorem assumes, what it concludes and whether it sheds a new light on the free will debate.

Here is a map of the paper. In Section 2 I present the assumptions and the structure of the proof to the conclusion that quantum mechanics and relativity entail free will for particles. In Section 3 I present the objections raised against the Free Will Theorem present in the physical literature, essentially that one of the assumption, namely MIN, is false. Instead, in Section 4 I focus on the impact of the Free Will Theorem on the free will debate. First, I observe that the theorem is question begging, since freedom is assumed in the proof. Then I argue that the authors do not even prove that if people are free, then so are particles. Moreover, I argue that if the criticism in

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[4] A more precise statement of Conway and Kochen’s thesis will be made clear later in the paper.

[5] *The New Scientist* (Merali 2006) has also reported it.

[6] When discussing some features of the free will compatible with quantum mechanics, they write that their remarks “might also interest some philosophers of free will” (Conway and Kochen 2006, p.1465).

[7] See, most notably Kane (1996), Compton (1935), Popper (1972), Nozick (1981), van Inwagen (1983), Penrose (1994), O’Connor (1995), Stapp (1991).

[8] See for instance Loewer (2003).

[9] To give an example of this attitude, even if quantum nonlocaltiy seemed to provide a knock down argument against Humean supervenience, David Lewis wrote: “if physics tells me that it is false, I wouldn’t grieve […] But I am not ready to take lessons in ontology form quantum physics as it now is. First I must see how it looks when it is purified of instrumentalist frivolity and dares to say something not just about pointer readings but about the constitution of the world; and when it is purified of supernatural tales about the power of observant minds to make things up” (Lewis 1986, p.xi).

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Section 3 are sound, then the theorem actually disprove locality rather than proving freedom of the will (4.2). In addition, even if such criticisms are incorrect, the meaning of "free will" used for people is not necessarily the same as the one used for particles, and in general it seems absurd to think that the meanings are the same (4.3). Finally, I present Conway and Kochen's Free State Theorem, which generalizes the Free Will Theorem without the assumption that people are free. I show that the problem with this theorem is that the notion of freedom for particles is either in tension with the assumptions made by Conway and Kochen, or it is a species of randomness, and therefore not freedom (4.4). Therefore, I conclude that the Free Will Theorem, in all its varieties, is a nice piece of mathematical work but its name suggests much more than it actually does: it does not entail anything about freedom, neither for us, nor for the particles.

2. The Free Will Theorem: SPIN, TWIN, FIN, MIN and DET

In their proof Conway and Kochen consider a particular experimental situation and assume few axioms called SPIN, TWIN, FIN (later, MIN), and DET. The experiment involves a pair of particles, *a* and *b*, with total spin 1 which are traveling in opposite directions, and two experimenters, *A* and *B*, that can perform experiments on the spin of respectively *a* and *b*. [10] Setting technical details aside, we can talk about the total spin of a set of particles, and the different values of each particle's spin depend of the direction we are measuring it. The two experimenters *A* and *B* each use a magnet that can be set to measure the component of the spin of the particle arriving toward them along one or another direction. In particular, experimenter *A* can perform an experiment on *a* to determine its spin along three orthogonal directions *(x,y,z)*; and experimenter *B* can perform an experiment on *b* to determine its spin along the direction *w*.

2.1. The Axioms

Quantum theory predicts that the possible results for these experiments are constrained so that only certain values can come out from the measurements. This is "the SPIN axiom: Measurements of the squared (components of) spin of a spin 1 particle in three orthogonal directions always give the answers 1, 0, 1 in some order" (1 p. 227). That is, the set of results obtained by *A* on *a* is always one of the triplets 1,1,0; 1,0,1; or 0,1,1; and the result obtained by *B* on *b* is always either 0 or 1.[11]

[10] One should not take this language too seriously, but for what is relevant to this discussion, one can imagine a particle like a spinning magnet, and think of its spin as its magnetization, so that we can measure the spin of the particle using a suitable magnetic field.

[11] Actually, SPIN is not properly an axiom but rather a theorem ((Kochen and Specker 1967), so that if quantum mechanics is correct, the results of such spin measurements have to be constrained as SPIN says.

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In addition, quantum mechanics predicts that it is possible to produce pairs of 'twinned' particles, whose individual spin properties are interconnected with one another. In other words, they are *entangled* particles. This is "the TWIN axiom: For twinned spin 1 particles, suppose experimenter *A* performs a triple experiment of measuring the squared spin component of particle *a* in three orthogonal directions *x, y, z*, while experimenter *B* measures the twinned particle *b* in one direction, w. Then if *w* happens to be in the same direction as one of *x, y, z*, experimenter *B*'s measurement will necessarily yield the same answer as the corresponding measurement by *A*" (Conway and Kochen 2009, p. 228). That is, whenever $w=x$ (respectively *y*, or *z*) then the outcome obtained by *B* coincides with the first (respectively second, or third) digit of the result obtained by *A*. That is, *A* and *B*'s results are perfectly correlated. Like SPIN, also TWIN is a consequence of the formalism of quantum mechanics. To emphasize that, in the following I will write QM=SPIN & TWIN.

The third assumption of the theorem does not come from quantum mechanics but from relativity theory. Since it deals with the finiteness of the velocity of light, the axiom is called "FIN" (from the first three letters of 'finite'): "there is a finite upper bound to the speed with which information can be effectively transmitted" (Conway and Kochen 2009, p. 1443). Angelo Bassi and GianCarlo Ghirardi (2007) as well as Roderich Tumulka (2007) have argued that FIN is equivalent to a locality condition, namely the assumption that events in a region of space do not affect events in a region which is space-like separated from it. If so, these authors claim, Conway and Kochen's result is another instance of Bell's theorem (Bell 1964) which shows that no local theory can correctly reproduce the predictions of quantum mechanics.[12] Therefore, these authors claim that Conway and Kochen's theorem, based on the false FIN assumption, is unsound. In response, Conway and Kochen (2009) reformulated the Free Will Theorem. They dub it the 'Strong Free Will Theorem' and they use another axiom instead of FIN, called MIN: "assume that the experiments performed by *A* and *B* are space-like separated. [13] Then experimenter *B* can freely choose any one of the [...] directions *w*, and *a*'s response is independent of this choice. Similarly and independently, *A* can freely choose any one of the […] triples *x, y, z*, and *b*'s response is independent of that choice" (Conway and Kochen 2009, p. 228). That is, when performing an experiment on the two twinned particles moving in opposite directions, there is always a minimum time the information needs for traveling from one particle to

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[12] Even if Tumulka, Ghirardi and Bassi believe that FIN is exactly the locality condition required in Bell's proof, there is a vast literature that discusses the various notions of locality: see Readhead (1989) for a review. Moreover, there is no full agreement on what Bell's theorem proves, as also remarked in footnote 16.

13 That is, the space distance between the two events is too large for a light signal emitted at one event to reach the other event, so that one event cannot cause the other. [This footnote is present in the original text.]

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the other (hence the name "MIN"). In other words, MIN says that the experimental outcomes for *a* are independent of what experiment *B* chooses to perform on *b* and vice versa. To simplify the notation since both FIN and MIN are a consequence of relativity, in the following, I will denote either FIN or MIN with R.

In addition to SPIN, TWIN and MIN, there is another assumption in the theorem, namely that the outcomes of the experiment performed on one of the particles functionally depend on the previous state of affairs. That is, there are two function, *Fa* for particle *a* and *Fb* for particle *b,* each of which expresses the results in terms of the initial state. This functional dependence is Conway and Kochen's definition of determinism (thus the assumption's name "DET"): "particle *a*'s response is a function [...] of the information [...] available to it" (Conway and Kochen 2006, p. 1445).

2.2. The Proof of the Strong Free Will Theorem

Here is my reconstruction of the proof. Assume DET: there are functions, *Fa* and *Fb*, connecting the experimental outcomes with the initial states and which express the results of the experiments on *a* and *b* respectively. Because of MIN, each of these results, say F*a*, does not depend on the experiment that *B* actually performs on *b*. Given SPIN and TWIN, *Fa* and *Fb* can assume only a certain range of values, and a particular relation between the two particular functions, called '101-functions, holds.[14] Conway and Kochen provide a geometrical proof that such 101-functions in the current experimental setting cannot exist (Conway and Kochen 2006, p. 1468). Therefore, it is impossible to have outcomes of experiments to functionally depend on previous states of affairs in ways consistent with the axioms QM (=SPIN, TWIN) and R(=MIN):

(1) (QM & R) & DET $\rightarrow$ contradiction.

To solve such contradiction one should reject one of the premises. Conway and Kochen argue that SPIN and TWIN, being at the heart of quantum mechanics, should not be rejected. Similarly, MIN being a consequence of relativity theory, is also difficult to deny. Therefore, they argue, the only (reasonable) option is to reject DET. Denying DET, Conway and Kochen continue, amounts to say that particles are free. That is, using an obvious notation in defining FW_particles = ~ DET, we have the "Strong Free Will Theorem" for deterministic theories ("strong Free Will Theorem for deterministic theories," or sFWTd):

(sFWTd) (QM & R) $\rightarrow$ FW_particles.

In their words: "the axioms SPIN, TWIN and MIN imply that the response of a spin 1

[14] The details of these functions are irrelevant for our purposes.

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particle to a triple experiment is free — that is to say, is not a function of properties of that part of the universe that is earlier than this response with respect to any given inertial frame" (Conway and Kochen 2009, p. 228).

Conway and Kochen additionally claim that "randomness won't help" (Conway and Kochen 2006, p. 1463). In fact, they propose a method of converting any stochastic model into a deterministic one: "let the stochastic element [...] be a sequence of random numbers (not all of which need be used by both particles). Although these might only be generated as needed, it will plainly make no difference to let them be given in advance. But then the behavior of the particles in such a theory would in fact be a function of the information available to them (including this stochastic element) [...]" (Conway and Kochen 2006, p. 1463). This analogy from Tarun Menon (2010) is helpful to understand the proposal: suppose you and your friend want to play a game of die, then you roll all dice before the game, write down all the results, and then use this fixed information to play the game. Conway and Kochen claim that we would still have the same sort of functional dependence (denoted with DET′ in the following equation) that gives rise to the contradiction noted above (assuming TWIN, SPIN and MIN are preserved in the stochastic-deterministic conversion):

(2) (QM & R) & DET ' → contradiction.

Therefore, the more general version of the strong Free Will Theorem, valid also for stochastic theories reads as follows:

(sFWTd&i) (QM & R) → FW_particles.

That is, it is a consequence of quantum mechanics and relativity that particles are free.

If the theorem really proves this, it is very good news for the libertarian: not only nobody could say that their view is contrary to physics, but also they would have a mathematical proof that they are correct! Unfortunately for them, however, I will argue in Section 4 that this is too good to be true. Nevertheless, before this, let me discuss in the next section the other criticisms that the theorem has received in the literature.

3. Criticisms 1: The Constraints on the Interpretations of Quantum Mechanics

In addition to this, Conway and Kochen take their theorem to be an "impossibility proof" against deterministic completion of quantum mechanics and the possibility of constructing relativistic invariant stochastic quantum theories. Quantum mechanics suffers from the measurement problem: if quantum mechanics is a theory only about the wave-function evolving according to the Schrödinger evolution, then unphysical "macroscopic superpositions," that is in superpositions of macroscopically different states of affair (like a dead and an alive cat), arise. Several theories have been proposed

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to deal with this, some of which are deterministic, like the pilot-wave theory (de Broglie 1928; Bohm 1952), others instead are stochastic, like the spontaneous localization theory (Ghirardi et al. 1986). The former avoids macroscopic superpositions postulating that the complete description of any physical system is given by the wave-function together with the particles position evolving deterministically. The spontaneous localization theory instead postulates that the wave-function evolves stochastically so that the macroscopic superpositions promptly disappear.

Conway and Kochen argue that their theorem rules these theories out. Since they claim that conditional (1) implies that determinism is false, they conclude that deterministic completions of quantum mechanics are impossible. Moreover, from conditional (2) they conclude that any stochastic completions of quantum mechanics so constructed cannot be made relativistic invariant, given that they would violate relativity (by violating MIN).

3.1. MIN in Deterministic Theories

Several authors have criticized these claims. Goldstein *et al.* (2010a) argue that MIN, like FIN, is equivalent to a locality condition, LOC, which entails that the (probability) distribution of the experimental results for *a* is independent of the distribution of the results for *b*. LOC, according to these authors, can be broken down in two conditions: parameter independence (PI) and outcome independence (OI). PI says that the experimental outcomes for *a* are independent on the parameters chosen by *B* for the experiment to perform on *b*; OI says that the results for *a* are independent on the results for *b*. For deterministic theories, since there is just one outcome, OI is trivially true and LOC reduces to PI. Since, according to these authors, in this case PI = MIN, then LOC = MIN. Therefore (sFTWd) reads:

(QM & LOC) & DET → contradiction.

The problem is that, according to these critics, Bell's theorem shows that:

(BT) (QM & LOC) → contradiction,

so that the contradiction in (sFTWd) is not resolved by rejecting DET, as Conway and Kochen do: one would have to reject either LOC or QM. Thus, the critics conclude, the sFWTd should be considered as an additional proof on nonlocality, on oar with Bell's theorem. As such, then, it does not pose any particular threat to the pilot-wave theory or any other deterministic completion of quantum mechanics[15]

[15] That deterministic quantum theories like the pilot-wave theory must violate parameter independence has been known for a long time, but apparently the fact has not been appreciated enough.

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Christian Wüthrich (2011) similarly claims that if DET is true, then outcomes of one arm of the experiment will depend on the settings of the other arm. Therefore, for any deterministic theory that violates PI, and therefore MIN, (sFWTd) does not apply.[16]

3.2. MIN in Stochastic Theories

Considering now (sFWTd&i), the theorem works only if, as Conway and Kochen propose, there is a method to convert any stochastic theory into a deterministic one, "putting all randomness into the past" (Goldstein *et al.* 2011a, p. 1455). However, Goldstein *et al.* (2011a) show that such method would make MIN false, and therefore would invalidate the conclusion that DET' is false. In fact, assuming MIN reduces to PI, then PI is violated by the conversion method proposed by Conway and Kochen because "if nature were to follow the recipe suggested […] then she should have to use the values of *k=k(x,y,z,w)* depending on both experimenters' choices, *(x,y,z)* and *w*, in order to produce any of the outcomes" (Goldstein *et al.* 2011a p. 1455). Therefore, according to these authors, the contradiction in (2) is again resolved because MIN is false, and not because DET' is false.

Goldstein and collaborators note that Kochen has suggested that MIN should not be interpreted as PI but rather "as requiring that the actual outcome itself of [one experiment] to be independent of B's choice, and not just its probability distribution." However, Tumulka (2007) writes that this strategy of pre-generating random information will not work for his proposal of a relativistic invariant spontaneous collapse theory. This is because the distribution of the flashes, the ontology of Tumulka's theory, depends on the choice of the directions of both arms of the experiment. If the distribution were given in advance, also these choices must be given in advance and they cannot because of DET'. In response, Conway and Kochen (2009) change their argument. Instead of pre-generating the information about flashes (which depends on the particular choice), they pre-generate the flash distribution of all possibilities. In this way, the choice together with the pre-generated information determines the particles' response. However, Menon (2010) claims that that would be a violation of (sFWTd&i) since the particles' response would not be independent of past information and thus they would violate DET'. Menon therefore identifies the real problem to be MIN. He believes that it incorporates a notion of "robust" causation, which is too strong.

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[16] Notice that critics disagree on what Bell's theorem proves: while Bassi and Ghirardi (2007), Tumulka (2016), Goldstein et al. (2011a) as well as Albert (1992), Maudlin (1994) claim that it proves nonlocality, i.e. ~LOC, Menon (2010) and Wüthrich (2011) instead seems to think that it rules out local deterministic completions of quantum mechanics, i.e. ~(LOC&DET). If it is the former, then Bell's theorem provides a constraint for all quantum theories: any quantum theory (deterministic or stochastic) has to deny locality. In contrast, if it is the latter, Bell's theorem provides constraints only to deterministic quantum theories, and not on stochastic ones. Luckily, this distinction is not relevant from the discussion in this paper. For a discussion on the relation of Bell's theorem and the free will theorem, see Cator and Landsman (2014).

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Similarly, Wüthrich (2011) argues that Conway and Kochen's argument against Tumulka either is an illegitimate way of introducing randomness, or it is legitimate but then it defeats itself.

4. Criticisms 2: Which Constraints the Free Will Theorem Actually Poses of the Free Will Debate?

Regardless of whether one considers the criticisms presented in Section 3 to be decisive or not, there are other concerns regarding the theorem's impact on the philosophy of free will. Therefore, let us assume for the sake of the argument that sFWTd&i works. If so, then physics (quantum mechanics and relativity) entails that there is free will in a libertarian sense, since the proof involves the denial of determinism. As emphasized, if true, that would be great news for the struggling libertarians. Let us see whether this is the case.

4.1. Begging the Question

Going back to the definition of MIN, one immediately sees that there is an additional assumption we haven't spelled out: "[...] experimenter *B* can f*reely* choose [...]"(Conway and Kochen 2009, p. 228, emphasis added). Thus, the core of (sFWTd&i) is that *if* the experimenters have free will, *then* also the particles are free. That is, the conditional strong Free Will theorem is:

(Cond.sFWT) $\quad$ (QM & MIN') & FW_people → FW_particles,

where FW_people is the assumption that experimenters have free will, and MIN' is the portion of MIN without such assumption. However, if so, the theorem begs the question: the problem for the philosopher interested in free will is to determine whether the experimenter has free will! Formulated in this way, therefore, the theorem loses much of its appeal to the libertarian philosopher.[17]

4.2. The Conditional Claim

Proving the conditional claim might nevertheless be interesting. However, if the criticisms in Section 3 are correct, Conway and Kochen do not manage to prove it. In fact, (Cond.sFWT) implies that:

(QM & MIN) & DET → contradiction.

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[17] Also Wüthrich (2011) claims that the theorem is question begging, even if in a different way: while Wüthrich is concerned on whether the Conway and Kochen theorem proves indeterminism, I am more concerned in whether it proves free will, and the literature on free will teaches us that the relation between lack of determinism and free will is not straightforward.

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For deterministic theories, if R=MIN=LOC, we have

QM & LOC & DET → contradiction,

that together with Bell's theorem (BT) implies that LOC is false, not that DET is. Hence, one cannot conclude that FW_particles=~ DET is true. In addition, deterministic models of indeterministic theories fail MIN, so that

(QM & MIN) & DET' → contradiction

implies that MIN is false, not that DET is. So again, we cannot conclude that FW_particles is true.

4.3. On The 'FW_people' and The 'FW_particles' Conditions

Even granting for the sake of the argument that the criticisms reported in Section 3 are mistaken, there are further problems connected to the fact that the notion of freedom for people discussed by Conway and Kochen is far from clear. If the result is (Cond.sFWT), is the assumption FW_people true?

Conway and Kochen say that FW_people is *presumably* true because it is the denial of determinism, and determinism is an implausible view, just like solipsism: "both the non-existence of free agents in determinism and the external world in solipsism are rightly conjectured up by philosophers as consistent if unbelievable universes to show the limits of what is possible, but we discard them as serious views of our universe" (Conway and Kocjen 2006, p. 1462).

However, consider what FW_people says: "experimenters are free to choose between possible experiments" (Conway and Kocjen 2009, p. 228). This sense of freedom is not incompatible with a deterministic universe: even if there is just one possible future, the experimenter does not know which one it is. Therefore, for all relevant purposes, one just needs an *epistemic* rather than a *metaphysical* notion of freedom. FW_people could therefore assert that the world is *as if* the experimenter can choose of orienting the magnet along a given direction. Since this is compatible with a deterministic universe, FW_people is not necessarily the denial of DET: it could just be a compatibilist notion of freedom. That is, even a compatibilist version of the FW_people assumption would do the trick for Conway and Kochen. Conway and Kochen, though, do not consider this possibility, since they regard determinism as "not serious:" they therefore want a libertarian notion of freedom. The problem though, is that they provide no argument for it: they simply write that if determinism is true then there is no way of making sense of science. However, this is not the case. Their worry seems to be that, if determinism is true then it would be pointless for an experimenter to perform

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experiments. If so, though, they are conflating predictability in practice with predictability in principle: if determinism is true it is possible in principle to predict the results of all possible experiments, but that does not mean that the experimenter actually has (or has to have) the necessary information to perform such computation. Thus, compatibilist freedom seems to be enough to make sense of science.[18]

In addition, the theorem is advertised as showing that "if indeed there exist any experimenters with a modicum of free will, then elementary particles must have their own share of this commodity" (Conway and Kocjen 2006, p. 1444). In other words, "if experimenters have a certain property then spin 1 particles have *exactly the same* property. Since this property for experimenters is an instance of what we usually call 'free will,' we find it appropriate to use the same term also for particles" (Conway and Kocjen 2006, p. 1444, emphasis added). That is, FW_people is the same property as FW_particles. However, we have just seen that FW_people is not necessarily the denial of DET (since it can be compatible with it), while FW_particles is, by definition. Thus, even if FW_people is true, the theorem does not show that the same property applies to people and particles.

Nevertheless, for the sake of the argument, assume that "FW" means the same thing for particles and people. Now the question is whether it is possible for particles and people to share a property like free will. Even if philosophers like Alfred Whitehead (1929) have arguably entertained such a view, it seems an implausible one: how can the property "FW" really mean what we ordinarily mean by free will and at the same time be attributed to people and to particles? This seems to involve a category mistake: while it seems appropriate (at least, intuitively) to consider observers as agents which may possess properties like free will, beliefs, desires, or knowledge, it does not seem to be sensible to ascribe these properties to particles, which are not agents, and whose typical properties are position, momentum, mass, or spin.

4.4. The Free State Theorem: Doing Without The 'FW_people' Condition

Let us set these considerations aside for a moment and consider the role the FW_people assumption plays in the proof of the Free Will Theorem. I argued above that it might simply express the idea that the world is as if different experiments can be performed, not that the world has actually an open future, which is perfectly compatible with a deterministic universe with a compatibilist free will. Because of this, it seems to me, the FW_people assumption should not be necessary in the proof. It is beyond the scope of this paper to see whether this is truly the case.[19] Interestingly enough, Conway and

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[18] Landsman (2017) has similarly argued that the notion of freedom in the free will theorem is a compatibilist one.

[19] See Menon (2010), Wüthrich (2011), Norsen (2017), Bell (1985), Clauser et al. (1985), Goldstein et al. (2011b), Maudlin (2014), Bricmont (2016), Tumulka (2016) and references therein for a relevant discussion in the context of Bell's theorem.

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Kochen seem to recognize that: "there is a modification of the theorem that does not need the Free Will assumption. Physical theories since Descartes have described the evolution of a state from an initial arbitrary of 'free' state according to laws that are themselves independent of space and time. We call such theories with arbitrary initial conditions *free state theories*" (Conway and Kochen 2009, p. 1447). Consequently, they propose a version of the Free Will Theorem that does not contain the FW_people assumption, which they call "The Free State Theorem," FST (Conway and Kochen 2006, p. 1447):

(FST) (QM & MIN) → FW_particles.

Conway and Kochen observe that it would be extremely unpleasant if the theorem would depend on FW_people. In fact, as many before them[20], they speculate that "it is natural to suppose that this latter freedom [of the particles] is the ultimate explanation of our own" (Conway and Kochen 2009, p. 230). However, if the conditional string free will theorem works at best it proves the opposite, namely that people's freedom grounds the freedom of the particles. Therefore, they need to prove FW_particles independently of FW_people, which they allegedly do with the FST.

Therefore, if the FW_people assumption is not needed and the FST is sound, we might have arrived to something interesting, namely that particles are free, regardless of whether we are. Nonetheless, does the FST prove that particles are free? Landsman (2017) have argued that the theorem should be seen from a compatibilist perspective. However, as already noted, Conway and Kochen explicitly reject compatibilism (since they reject determinism), so that they have to go with a libertarian notion of free will for particles. However, we have already seen that this is difficult to define: the core idea of libertarians is to attribute free will to people as agents and never to particles, in virtue of the fact that agents have properties that particles do not possess. In other words, in the libertarian framework we are fundamentally different from particles: in particular, particles have no free will, only we, as agents, do.

Another option for Conway and Kochen is not to invoke agency and to stick with their definition of FW_particles as the denial of determinism but still different from randomness. Indeed, Conway and Kochen suggest that 'free particles' means 'particles that are randomly behaving constrained by the axioms of quantum mechanics.' They write: "the freedom we have deduced for particles is more constrained, since it is restricted by the TWIN axiom" (Conway and Kochen 2009, p. 230). In other words, particles' behavior is not described functionally and it is constrained by TWIN, while randomness is behavior is completely without constraints. This is compatible with their assumption that FW_particles = ~ DET. However, I think that this does not help at all:

[20] See e.g. Kane (1996).

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constrained randomness is, for all our purposes, still randomness, and the traditional objections that randomness is not freedom still hold. This constrained randomness implies that the behavior of particles is governed by laws which put constraints on their random behavior. This means that particles are string puppets whose strings jerk randomly but, say, cannot exceed a certain limit. As in the case of pure randomness, particles are not in control of their behavior. If one wishes, one can call this 'freedom' but this notion has not much to do with our common understanding of freedom.

To conclude, I think that the impact of the theorem on the free will debate is disappointing. In fact, even if the theorem proves something about the property "FW_particles," such property is either inconsistent, given that libertarian freedom attributed to particles seems an oxymoron, or it is 'constrained' randomness, and as such it is difficult to see how it may have something to do with the concept of freedom as traditionally intended.

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