Dispositional Structuralism

Best of the two worlds

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Abstract

Humean Metaphysics has been attacked both by Structural Realists who don't believe in individuals and their intrinsic properties and by dispositionalists who see necessity in nature. It is now a growing tendency to bring these two camps together. From the dispositionalist camp, Alexander Bird uses structures to solve the problem of regress in powers and also their identity. On the Structural realist side, Michael Esfeld appeals to powers to face the Kantian Humility challenge. We will argue in this paper that all of these attempts are doomed. We will introduce different versions of dispositionalism and structural realism in the first section. Bird's view on the identity of powers has been criticized in the second section. In the third section, we will show appealing to GRW will threat structural realism. Finally, we will offer our proposal to meet Kantian Humility challenge.

1. Introduction

There are two main views on the nature of properties. On the first view, namely categoricalism, identity of properties is primitive. It means that their identity does not depend on their nomic or causal role. On this view, there may be properties that are dispositional. These dispositions, however, do not constitute the nature of those properties. For instance, an object with the mass m, has a disposition to accelerate with the acceleration F/m if it is subjected to the force F. This disposition, however, does not play any role in making the property of having the mass m. There are some possible worlds in which our object subjects to the same force but its acceleration is $(F/m)^2$.

According to the second view, namely dispositional essentialism, properties have the same dispositional characters in all possible worlds. Their identity is not primitive and depends on their causal powers. In our example, if the property of having mass m gets instantiated by an object in a possible world, if that object subjects to the force F, it will necessary get accelerated with the acceleration F/m. Since, the power to accelerate with the acceleration F/m is one of the constituents of the property of having mass m. Accordingly, the relation between m and F remains the same across all possible worlds.

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The second topic which we are going to take a look at this talk and it seems prima facie irrelevant to the previous topic is ontic structural realism (OSR). There are at least three versions of OSR namely Eliminative OSR of James Ladyman (Ladyman and Ross, 2007), non-eliminative OSR of Esfeld (Esfeld, 2004) and the Intermediate OSR of Lyre (Lyre, 2009a), (Lyre, 2009b).

Structural realism (SR) was proposed by John Worrall to break the impasse that results from the pessimistic meta-induction argument (Worrall, 1989). Worrall suggested that in order to avoid Pessimistic meta-induction attack, a realist should commit herself to the mathematic or structural content of her theories and she should give up her commitment to the existence of entities described by her theories. Even granting that Newtonian Mass and Einsteinian Mass are quite different entities does not force us to reject the idea that there can be structural similarities between Newtonian Physics and Relativity. It appears for Worrall that although world may contain individuals and their intrinsic properties; our knowledge of the world confines itself within the limit of structures. We know nothing about things save their relations.

Later on, another version of SR was born (Ladyman, 1998). According to this eliminativistic version, there is nothing in the world but structures. Contemporary physics, especially quantum mechanics raises serious doubts about the individuality of objects. The most important challenge that this view faces is how to make sense of the idea of having a relation without having any relata.

Facing this challenge, Esfeld proposed another version of OSR the so-called non-eliminative OSR (Esfeld, 2004). According to this version, physical structures are networks of concrete, qualitative physical relations among objects that are nothing but what stands in these relations, that is, do not possess an intrinsic identity over and above the relations in which they stand. This position takes notably the entangled states of elementary quantum systems and the metrical relations among space-time points to be concrete structures in this sense.

As Lyre has pointed out the main problem with the non-eliminative version is that it is not moderate enough (Lyre, 2009a). It turns out as a natural consequence of commitment to structure that not only the relational properties but also the structurally derived intrinsic properties must be taken into account.

According to the last version of OSR, the intermediate version, there are relata and structurally derived properties, but there is nothing more to the relata that the structurally derived intrinsic properties, where the structure is comprised structurally derived properties. Properties like spin, mass, etc are structurally derived intrinsic properties which are comprised of the associated structures.

On this view, intrinsic properties supervene on the structures. According to Humean Metaphysics, however, the converse is true. We will come back to this view later on.

Let us say few words on the representation of natural structures before we move to the next part as we will refer to a specific form of representation. James Ladyman forces structural realists to view theories as models not propositions (Ladyman, 1998). One of the main approaches concerns theories as meta-linguistic entities is suppes-sneed's. In accord with this view, for instance, the structure of Classical Particle Mechanics (CPM) (Sneed, 1979, 115) is < P, T, s, m, f >, which is axiomatized relevantly. In the structure, "m" denotes mass, "f" force, "s" position, "T" and "P"

indicate time and position respectively as well. Regarding Lyre's ontic structural realism, notwithstanding property having mass "m" is an intrinsic property[3], it is structurally derived from the structure CPM.

2. Facing the regress problem

One of the most important difficulties with dispositionalism is the problem of indeterminacy of power's identity. Here is how Ellis (Ellis, 2002, 171) characterizes this problem "If all of the properties and relations that are supposed to be real are causal powers, then their effects can only be characterized by their causal powers, and so on."

In other words, If identity of powers and properties depends on their manifestation and those manifestations are powers themselves, then we will trap in an endless regress to identify them.

According to dispositionalist, identity of powers is grounded in their causal powers. These powers are nothing but dispositions to display certain manifestations in response to a certain kind of stimulus. Let P refer to a property and let $\Re(P, M, S_1, S_2, \dots, S_n)$ refer to its power[4]. Therefore, an object has property P, if given the presence of stimulus $S_1, S_2, \dots, S_n$ (which are themselves properties) manifests M. (we will call M manifestation property). It is needless to say that a property can have different powers. If a property has different powers, we can use all of its powers using our notation. Now we have the following identity condition for two properties:

Property P is identical with property T if the set of its powers, i.e. $\{\Re, \Re', \Re'', \dots, \Re^n\}$ *is identical with the set of powers of T, i.e.* $\{\mathcal{H}, \mathcal{H}', \mathcal{H}'', \dots, \mathcal{H}^n\}$.

In other words if we want to know whether two properties are identical, we have to look at the set of their (causal) powers. Two sets are identical if they have the same cardinality and also their members should be identical pair wise.

How do we know two powers are identical? We propose the following condition:

The causal power $\Re(P, M, S_1, S_2, \dots, S_n)$ *is identical with* $\mathcal{H}(P', M', S_1, S_2, \dots, S_n)$ *if and only if* $M = M'$.

And now, the regress difficulty arises. M and M' are properties and they need identity conditions. To avoid the regress, Alexander Birds appeals to graph theory. He put his solution nicely: By assuming that the structure of a graph contributes to determining the identity of its vertices, we are assuming, in effect, that the identity of a power is determined by structural preserving features of graph, i.e. trivial automorphisms. The main idea is that if graph's vertices represent causal powers and its (modified) edges represent the three place relation of power, manifestation property and stimulus property, then graph structural properties like trivial automorphisms can determine vertices identity.

[3] The function "m" is monadic in this structure.

[4] To indicate that the relation R is related to the property P, we take P at the argument.

We just have to modify our notation as vertices or edges here are not properties but rather casual powers. Suppose an object which has the property P when subjected to stimulus$S_1, S_2, \dots, S_n$, it displays manifestation M. Let CP_{S_i} be the causal power of stimulus property S_i and CP_M be the causal power of manifestation property M. We have $\Re(P, CP_M, CP_{S_1}, CP_{S_2}, \dots, CP_{S_n})$. For the sake of simplicity, we suppose that each property has only one causal power. The corresponding structure for property P is $< A, \Re >$, while $A = \{ CP_M, CP_{S_1}, CP_{S_2}, \dots, CP_{S_n} \}$

Now, using Bird's criterion of identity, we will have the following:

Causal power CP_A associated with structure $< A, \Re >$ is identical with causal power CP_B associated with structure $< B, \mathcal{H} >$ if and only if for every automorphism f from $< A, \Re >$ to $< B, \mathcal{H} >$, we have: $f(CP_A) = id(CP_A) = CP_B$

Put it briefly, in Bird's view, the identity and distinctness of the vertices of a graph supervene on the structure of that graph which is represented by trivial automorphisms.

At first glance, it seems regress disappears. What determines identity of powers is structural relation between powers. However, Bird's solution ignores something really crucial. Structures are like powers themselves. Suppose in order to identify CP, we appeal to structure A. we will call CP and A fist order causal power and first order structure respectively. We may have second order powers and if there are any, then we just have to appeal to second order structures to identify them. Regress reappears. In other words, if want to identify a power, we have to identify the structure in which that power plays a role in. Structures are power themselves and in order to identify them we need higher order structures in which the first structures are playing a role.

3. Structural realist undermines structural realism

As we mentioned earlier, SR was suggested to safeguard scientific realism against pessimistic meta-induction. However, SR not only saves scientific realism from this antirealistic argument but meets the challenge of underdetermination of theories nicely. According to this thesis, we can always have different scientific theories with incompatible ontologies being empirical adequate. For example, Bohmian interpretation and the orthodox interpretation of QM are two different theories with equal empirical adequacy; despite the fact that particles are always localized in Bohmian ontology, there is no such constraint in the orthodox interpretation.

But if we commit to structures instead of objects we may get rid of underdetermination. Structural realist believes that two different theories with equal empirical adequacy have equivalent mathematical structures. If so, scientific realist must commit to these shared structures.

However, the structural realist may suppose yet that the world is made of objects and their intrinsic properties *as well*. If we go further and claim that either there is no object (eliminative OSR) or relational properties are independent of intrinsic properties (non- eliminative OSR), then in addition to SR we are committed to a thicker metaphysical thesis. But OSR as a more advanced theory in comparison with SR should be consistent with it**.** However, as we shall see in later on, Esfeld's dispositional version of OSR cannot do the job of SR, i.e. protecting scientific realism against the

underdetermination threat. We will see that Esfeld's dispositional structuralism marriage to his preference towards a particular interpretation of QM, i.e. GRW, is doomed to failure and faces the underdetermination challenge.

Esfeld argues that (Esfeld, 2009) if structures are categorical and if they lack causal powers as their constituents, nomic relations governing them are underdetermined. This argumentation applies to properties in a similar way: if properties are purely qualitative and have primitive identity, then there are no unique laws governing them. If categoricalism is true, laws of nature are redundant.

In addition to this metaphysical problem, categoricalism raises an epistemological challenge called Kantian Humility. In fact, we know what properties are capable of doing and this knowledge comes from physics. As an example, consider property of "having mass m". If an object possess it and it is subjected to force F, it gets the acceleration F/m ; it exerts gravitational force F_g on other masses and etc. All of these are knowledge about what the property of "having mass m" can *do*. However, according to categoricalism, there is no constitutional relationship between what a property does and the identity of that property. Then, it is possible to have two quite different properties with similar dispositions. It is implied that our knowledge about objects restricted to the relational properties of them and does not comprise their intrinsic properties. What we will have here are two kinds of underdetermination: the underdetermination of nomic laws by intrinsic properties and the underdetermination of intrinsic properties by their causal powers.

Tow underdeterminations would disappear provided that the causal features of properties constitute their identity. If properties are exhausted by what they do, nomic laws would be identified uniquely with them, since laws are nothing but causal relations between properties. Having structures instead of objects and conceiving structures as categorical entities, two underdeterminations will arise again regarding structures. Firstly laws governing structures would not be identified uniquely, and secondly one group of laws governs different sets of structures. In accord with what argued, Esfeld concludes that structures lack primitive identities and what they do play a constitutional role in making their identity.

Is there any place for powers in contemporary physics? Dorato and Esfeld recently argued that not only there is, but one of the interpretations of QM, i.e. GRW supports strongly a metaphysic based on powers (Dorato and Esfeld, 2010), (Esfeld, 2009). They think that we should conceive entangled states as states which are available to manifest themselves. In other words, such states have dispositions to manifest themselves as product states and manifest classical properties. The states concerning non-massless particles in GRW interpretation is another example which have the disposition to localize spontaneously: "it will on average take 10^{16}s for such an isolated system to undergo a spontaneous localization" (Dorato and Esfeld, 2010, 42). A remarkable point regarding the latter example is that its manifestation does not need triggering and stimulus conditions. Because of that these localizations are called spontaneous ones. They use this feature of fundamental powers to avoid the regress objection against the causal theory of properties. However, it seems to us that they miss the point of the regress objection.

In a sense, what they do is naturalizing the best metaphysics: It is the best metaphysics, since the metaphysics based on powers meet the challenge of two underdeterminations. On the other hand, the ontology of GRW is grounded on this metaphysics. Thus, dispositionalism as the best metaphysics concerning properties has been naturalized by GRW interpretation of QM. However, we

shall show that their approach will be subjected with two main objections. Firstly, appealing to one of the interpretations of QM is against the spirit of SR. Secondly, the spontaneous localization as a manifestation without triggering conditions cannot solve the regress objection.

Let us see the first problem. As mentioned earlier, securing scientific realism against the underdetermination of theories by evidence is one of the virtues of SR. According to SR, what really matters ontologically is structure, not *apparently* objects and their intrinsic properties. Then the ontological difference of theories in terms of different objects they postulate and their intrinsic properties does not matter at all, since structural realist does not commit herself to these entities. On the other hand, the structural realist may show that there are shared structures between rival theories. So one world exists; a world to which the shared structures apply. Non-relativistic quantum mechanics is a place in which rival interpretations play an important role. There are various interpretations of this theory each of which has a different ontology. The Structural realist would explain the situation in the following way. All of these interpretations have shared structures and what one must commit herself to its existence is those shared structures.

However, as we found, Dorato and Esfeld observing the support of the best metaphysics by GRW countenance it:

"Our claim is that GRW is a fundamental theory, because it regards propensities for localization as ontologically primitive" (Ibid, 46)

“A quantum ontology in terms of dispositions is usually tied to those interpretations of quantum theory that admit state reductions, GRW being the most elaborate of them.”(Esfeld, 2009, 191)

But underdetermination problem arises again when we appeal to the meta-empirical virtues, (i.e., metaphysical virtues in this case). For example, take Bohmian interpretation of quantum mechanics. An advocator of this interpretation prefers its ontology, since she thinks it is almost the same as the classical physic’s, its probability is based on ignorance like in classical physics, other meta-empirical virtues could be called for. Hence again the realist is facing the question that whether the world looks like what is described by GRW interpretation or what is described by Bohmian one?

Does this mean that there couldn’t be a naturalized metaphysics? Our answer is negative. What we stress is the following. if the structural realist wants to naturalize metaphysics, then she cannot firstly choose one interpretation among rival ones and revise her ontology based on her chosen interpretation. Therefore, she either has to confine herself to the limits of the shared structures or she has to give up SR. To the best of our knowledge, no work has been done on the shared structure of different interpretations of quantum mechanics. However, da Costa and Bueno (da Costa and Bueno, 2010) have offered a viable pertinent plan. The shared structure of these interpretations is a partial structure and the different interpretations of quantum mechanics are its normal structures. If structural realist insists on appealing to quantum mechanics' implications in naturalizing metaphysics, she has to appeal to this partial structure and dismiss the normal ones.

But the second problem, i.e. the problem of regress of casual powers, is formulated by Dorato and Esfeld in the following terms:

“If properties are powers and if powers always need external triggering conditions, then it seems that the triggering condition b for power a is itself a power that needs a triggering condition c for exercising its triggering ,etc.”(Dorato and Esfeld, 2010)

But it seems to us that the genuine problem with the regress objection is not related to their manifestation, but it is the challenge to their identities. Let us assume that the relation $\Re(P, M, S_1, S_2, \dots, S_n)$ is the constituent of property P. Let us suppose that the manifestation of P does not need the triggering conditions as Dorato and Esfeld suppose. But if P is to be understood casually we could not overlook the effect of its manifestation property on its identification: a property is a property for the sake of *what it does*, even if there is no need to triggering condition for the manifestation of *what it does*. So we can eliminate triggering conditions and regard $\Re(P, M)$ as the constituent of the property, but M in turn is a property which bonded to its powers. We suspect what Dorato and Esfeld suggest helps us to identify the manifestation of properties rather than the indeterminacy of their identities.

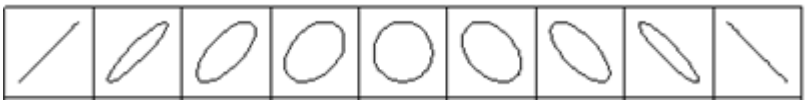
We found that how Dorato and Esfeld attempts failed in merging structuralism with dispositionalism. In the next section we will show how it is possible to merge structuralism with dispositionalism by defining casual powers of a property according to models of a structure in which the property comprised, and avoid two underdeterminations remarked by Esfeld afterwards.

4. New dispositional structuralism and solving the Kantian Humility Objection

Why should we bring dispositionalism and structuralism together? A good reply is Esfeld's: to avoid the underdetermination of laws and the underdetermination of intrinsic properties we *must* relate them closely. But there is another point we want to draw your attention to. We suspect these two metaphysics do have much in common. Both of them reject quidditism which says identity of properties is primitive and does not supervene on other entities including causal powers. But dispositionalists by definition believe that causal powers of a property bring about the identity of the property. But on the other side, structuralist also does not accept the constitutional independency of properties and what they do, i.e. their causal powers.

Remember the intermediate OSR. According to this version, properties comprised a structure would be identified by structural features of that structure. Then, it is impossible to have transworld identity of a property without preserving the identity of a structure which comprises that property. This latter conclusion implies preserving the laws governing the structure or characterizing it. Then by transferring a property across possible worlds, what it does must be transferred too. Consequently, identity of a property is not primitive and depends on the structural features of a structure comprises the property.

Before introducing our own dispositional structuralism, let us take a look at a physical example. Consider a body connected to two orthogonal springs. If spring constants are equal, the body would take various trajectories depending on initial spatial conditions. Some examples of these trajectories which are called Lissajous are depicted bellow:



A dispositional philosopher facing these trajectories would say that "a body connected to two orthogonal springs has dispositions to take Lissajous trajectories, depending on initial spatial conditions as various triggering conditions". In fact, Lissajous trajectories are different manifestations of different triggering conditions.

Regarding the structure of classical particle mechanics CPM, let us denote the theoretical structure describing behaviors of springs with $x = < P,T,s ,m,f=-ks >$, while K indicates the spring constant. All of Lissajous trajectories correspond to concrete models of this structure. Thus we could say that the *theoretical structure of spring has dispositions to manifest its models*. We call identifying causal powers of a structure by models of the structure *Dispositional Structuralism*. Powers associated with a theoretical structure are themselves structures but concrete structures which are realized in space-time. For example, structures like entangled states are concrete models of the structure of QM. To relate structural ontology to Humean ontology, we may say roughly that the causal powers of a property comprised a structure, are models of that structure. For instance, causal powers of the property "mass m connected to two orthogonal springs" are models of the theoretical structure $x = < P,T,s ,m,f=-ks >$.

Now we shall show that dispositional structuralism get rid of the two underdeterminations. First of all, structures have modal features and dispositions to manifest. It is obvious that with transferring the structure $x = < P,T,s ,m,f=-ks >$ from a possible world W_1 to another possible world W_2, all of its models would be transferred too. On the other hand we know that these models are realized according to the laws characterizing the structure. Consequently, structures indentify laws uniquely. So there would not be any underdetermination regarding nomic relations.

Let us see how suggested dispositional structuralism meets the challenge of the underdetermination of intrinsic properties or Kantian Humility. Categoricalist may know only what properties *do*. On the other side, what a property does is independent of the nature of that property. Then it is possible to change a property with preserving what it does. However, according to dispositional structuralism, what a structure does or its causal powers are just its models. Consequently contrary to what categoricalists claim, we cannot change a property without changing its models; if the identity of a structure is changed, their models should be changed. But how can we conceive a theoretical structure? Dispositional structuralist answerers this question easily. By observing concrete models of a structure, we discover that structure. Thus, there is no place for Kantian Humility.

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