Causation and Structural Realism

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Abstract: M. Esfeld has recently argued that ontic structural realism may succeed only if it is based on causal structures. In order to meet this requirement, he offers a combination of dispositional/causal relations with moderate form of ontic structural realism. This paper, however, demonstrates that moderate position, in relation to causation, faces a dilemma whose resolution leads to a monistic ontology that creates a rather hostile environment for structural metaphysics.

Keywords: M. Esfeld, scientific realism, structural realism, causation.

Introduction

Structural realism is a form of scientific realism. According to scientific realists, entities – both observable and unobservable – posited by our most successful scientific theories exist. They believe that observable phenomena are grounded, and thus explained, by unobservable. For instance, physical features of ordinary objects are based on the properties of atoms that are, at least with the unaided senses, unobservable. In similar fashion, observable symptoms of a patient are explained by unobservable viruses and, for realists, both viruses and the symptoms objectively exist. This is rather sketchy exposition of scientific realism, but things are more complicated because there are several branches and sub-branches within the doctrine. Scientific antirealists, on the other hand, deny entities outside the realm of observable. For antirealists, unobservable phenomena are theory or social dependant constructs that can't enjoy the same ontological status as observables. Thus, within the line of antirealism, features of ordinary objects and patients' symptoms, as observables, objectively exist, whereas atoms and viruses don't. One of the arguments of antirealists

against scientific realism is based on underdetermination. Consider two rival theories, T1 and T2, whose successful empirical predictions are alike, but their theoretical machineries – unobservables – differ. How can we test T1 and T2 and decide which of them correctly posits independently existing unobservables? For antirealists, data is insufficient to determine the answer because both T1 and T2 are compatible with the same empirical evidence.

This paper examines a recent account of scientific realism proposed by M. Esfeld (Esfeld 2009) that directly responses to the underdetermination argument. In the light of the paper, underdetermination is necessary if the content of scientific theories contains causally idle components with no detectable effects. On the other hand, if the content is exhausted by the entities with causal dispositions, which is Esfeld's idea, then every entity posited by a scientific theory (including unobservables) has a power to produce observable effects that can be, in principle, either confirmed or refuted by evidence. As a result, in case of causally active entities, underdetermination is blocked. In more detail, Esfeld's approach to scientific theories is structural. This means that the contents of scientific theories are structure-like rather then object-like. As Esfeld suggests (Esfeld 2009, Section 3), causal dispositions should be ascribed to relations in which objects stand, and this suffices to make unobservable structures detectable and, therefore, immune to underdetermination.[1] As it is explained, if the underlying fundamental physical structures were causally idle, then for any possible world there would be another possible world with the same causal features, but with different underlying (categorical) structures (Esfeld 2009, 6). As its knowledge is confined to detectables, science has no resources to recognize such fundamental difference between the worlds and scientific realism is lost.[2] Nevertheless, this paper argues that Esfeld's response to the underdetermination argu-

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[1] Consider unobservable spacetime structure – metric relations distributed onto a variety of manifold points. Esfeld understands spacetime as causally active because metric relations, as dispositions, produce effects that are, in principle, detectable (Esfeld 2009, 12).

[2] It seems that this form of scientific realism is confined to causal theory of knowledge; see Taliga (2009).

ment is questionable. It faces a dilemma that can be avoided by an extremely revisionary monistic ontology. However, as will be shown, such ontological position is rather hostile to structural metaphysics.

1   Moderate Form of Ontic Structural Realism

Structural realism, as a form of scientific realism, replaces object-like view of scientific theories with structural, but it is not obvious how far it should go. There are two basic variants of structural realism: epistemic and ontic (OSR hereafter). The oldest one, defended by Poincaré and Russell (Chakravartty 2003, 868), is epistemic. Its defenders place a restriction on scientific knowledge in the sense that we can know structural aspects of (unobservable) reality, but nothing about the natures of things whose relations define structures (Chakravartty 2003, 867). However, undetectables (notably intrinsic natures of objects) open a gap between structural knowledge and metaphysics and thus block scientific realism. The point is that if there were inaccessible objects, then the world would contain more entities then science can, in principle, discover. OSR, on the other hand, attempts to close that gap. It comes in two forms: radical and moderate.[3] Radical OSR claims that there are relations but no objects. Objects play only a heuristic role, allowing for the introduction of the structures which then carry the ontological weight (French 1999, 204). Within this line of reasoning, objects with undetectable intrinsic natures are thrown away, and the harmony between structural knowledge and metaphysics is restored. However, the most controversial consequence of this solution is its commitment to conceptually confusing "object-less structures" that assume "relations without relata". Moderate OSR eliminates this unpleasant outcome, but still attempts to preserve the benefits of structural ontology. Moderate OSR keeps the gap between structural knowledge and ontology closed by putting objects (both metaphysically and epistemologically) on a par with relations (Esfeld – Lam 2008, 31). This, however, is not a return to traditional object ontology because moderate OSR views the identity of objects extrinsically, whereas object ontology does so intrinsically. Object ontology

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[3]   Esfeld is a promoter of moderate OSR.

holds that objects enter relations with definite identities, whereas moderate OSR denies this:

> … 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.[4]   (Esfeld 2009, 1)

Obviously, objects are no problem to structuralism if their natures are entirely relational. As a matter of fact, the rejection of intrinsic identity only follows a general strategy of moderate OSR to reject intrinsic properties as such. One of the slogans of object ontology – to know an object is to know its intrinsic properties – is denied by moderate OSR:

> The argument is, in brief, that we gain knowledge of physical objects owing to the causal relations that obtain between the objects and our senses or our measuring instruments. […] In other words, the fundamental intrinsic properties of the physical objects are beyond the scope of our knowledge, because we have access to these objects only in a relational way.   (Esfeld – Lam 2008, 28 – 9)

In sum, moderate OSR suggests structures composed of objects that are devoid of intrinsic properties, and whose identity conditions depend on relations in which they stand. According to Esfeld's recent contribution, relations should be causal/dispositional, and this is the topic of the following paragraph.

2   Causal Powers

Esfeld argues that OSR faces underdetermination if its structures are causally inert, and so he proposes a dispositional/causal approach. This suggestion also replies to another traditional objection against OSR, which is seen in OSR's inability to accommodate causation (Psillos 2006, 569). However, Esfeld doesn't agree with the advo-

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[4] Space-time points may serve as an illustration: … the identity of space-time points is completely determined by the space-time (chronogeometrical, inertio-gravitational, causal) relations they exhibit, that is, their 'position' in the (generally covariant) network of space-time relations (Esfeld – Lam 2008, 38).

cates of radical OSR who maintain that causation disappears at the fundamental levels of physical reality, and OSR – as an ontological framework of fundamental physics – only reflects this fact (Ladyman – Ross – Spurrett – Collier 2007, 259). In the light of Esfeld's account, non-causal/categorical structures, with no detectable powers, are bound up with ontological underdetermination (Esfeld 2009, 9).[5] He defends this claim with the arguments of dispositionalists against the categorical view of properties. The categorical approach perceives properties as based on their non-causal intrinsic natures (*quiddities*) independently of causal or nomological relations. But this, according to dispositionalists, is a mistaken view. Consider the following *Reductio* argument proposed by J. Hawthorne:

> Suppose a property is something over and above its causal profile. We then seem to have conceptual space for something like the following: there is negative charge 1 and negative charge 2 that have exactly the same causal powers. What we call an instance of negative charge is sometimes an instance of negative charge 1, sometimes an instance of negative charge 2. Since 1 and 2 have the same propensities to affect all possible detection mechanisms, there is no way of discriminating 1 and 2. We would now be unable to tell, it seems, whether two groups of particles that we call 'negatively charged' had the same property or else distinct but indistinguishable properties. But this is absurd: we can recognize property sharing. So we had better not allow properties to have an individual essence that transcends causal features. (Hawthorne 2001, 215)

And Esfeld strictly follows this advice, because a shift from categorical properties to categorical relations/structures faces the same underdetermination problems: categorical relations/structures also allow for causally indiscernible worlds grounded in different fundamental structures. Assume that W1 and W2 are such possible worlds. In regard to observables, W1 and W2 are indiscernible because their causal features are alike. As for their underlying fundamental struc-

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[5] Although French, Ladyman and Ross express the commitment of OSR to modal structures (as opposed to categorical), they are not explicit about the structures' modal nature and standing (French 2006, 172; Ladyman – Ross – Spurrett – Collier 2007, 67). As Esfeld puts it, his dispositional approach is an attempt to fill this lacuna (Esfeld 2009, 2).

tures, W1 and W2 differ. Problem is that science has no resources to recognize that difference because the fundamental structures of W1 and W2 don't produce detectable effects. That consequence is incoherent with scientific realism and creates a space for underdetermination: the data is insufficient to determine the correct theories of W1 and W2.

Once again, one of the main arguments in Esfeld (2009) is that scientific realism is preserved, and immune to underdetermination, only if OSR eliminates mysterious *quiddities* and keeps its structures causal. So far so good, but this delineation of OSR will be spoiled by objects.[6]

3   Moderate OSR and Causal Powers

It looks, according to the previous paragraph, as if Esfeld was shifting causation from objects to relations and thus proposing a truly structural notion of causation. Unfortunately, this cannot be true, because a separation of objects from causation would turn objects into mysterious undetectables.

What is then a source of causation? If relations, then, as has just been said, objects are in trouble because they would be causally idle and inaccessible. In order to evade this consequence, causal powers should be ascribed to objects as well, but then objects acquire properties "in isolation", that is, independently of relations. Such a non-structural explanation, which introduces causal properties as intrinsic to objects, must be avoided too. Thus moderate OSR faces the following dilemma:

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[6] Esfeld's proposal is also entrenched in problems concerning the analysis of causation in terms of dispositions: Is the relation between causes and dispositions a supervenient relation? Is it an identity relation? If it is identity, is it contingent or necessary? Is the analysis of causes in terms of dispositions reductive or non-reductive? If it is reductive (and leads to something non-causal, e.g. regularities), then it faces ontological underdetermination; if the analysis is non-reductive, then it is circular.

(1)   If objects are causally passive, then they are beyond the scope of scientific knowledge and, therefore, incompatible with moderate OSR.

(2)   If objects are causally active, then they acquire qualities independently of relations in which they stand and, therefore, are incompatible with moderate OSR as well.

This dilemma can be settled only if both objects and relations are causally active, and if the structural ontology is preserved. According to Esfeld, these requirements are met by an account of dispositional relations as inseparable modes of objects.[7] This idea is borrowed from J. Heil:

> … property-bearers are objects considered as being particular ways, and properties are ways objects are. In considering an object as a property-bearer, we are considering it partially; in objects considering its properties, we are considering ways it is, another kind of partial consideration. Properties and property-bearers can be considered separately but they cannot be separated, even in thought.   (Heil 2003, 172 – 73)

This account avoids the dilemma because it rejects the ontological dualism of objects and the relations that powers it. An object and its modes are, according to Heil, two inseparable aspects because the identity of a property cannot be separated from the identity of its possessor, and *vice versa* (Heil 2003, 46). The resulting entity is a thick particular that contains its bearer and its inseparable attributes. If we apply this account to a relational setting and consider, for instance, a space-time point, then it represents a thick particular consisting of a manifold point (as a bearer) and inhering metric relations as its particular modes. This entity is causally active (because its modes are causal) and devoid of intrinsic properties (because its modes are only relational), and thus the introduction of causality to structures (in this

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[7]   Esfeld put forward this account as a response to the above dilemma in an e-mail exchange. His writings are not explicit about this aspect of moderate OSR. In addition, relations as modes of their relata prevent moderate OSR from becoming a mere version of the bundle theory (object as a bundle of relations), which is another objection raised against Esfeld, see Dorato (2008).

case metric) seems to have been successfully accomplished. This conclusion, however, comes at a cost that structuralists, as I will try to show, are not likely pay.

Heil's views become more radical when applied to relations. Return to space-time points and their relational modes. Consider O1 and O2 as spatio-temporal points standing in a metric relation R. In Heil's vocabulary, R is a mode shared by both O1 and O2, and since modes are ontologically inseparable from their bearers, O1, O2 and R constitute a thick particular. Further assume that O2 stands in relation S to some third spatio-temporal point, point O3. O3, with its mode S, ontologically joins that thick particular and we get a more complex entity consisting of O1, O2, O3 and their relational modes R and S. Growing complexity is not a problem; the problem is that the entity's apparent constituents condition each other's identities. O2 contributes to the identity of O3 (by sharing mode S), and since O1 contributes to the identity of O2 (via mode R), then O1 also contributes to the identity of O3. Something similar holds for relations R and S, because they are both modes of O2. As the metric field spreads, you end up with space-time as *one indivisible thick particular* whose constituents are thoroughly dependent on each other: the identity of each constituent (be it object or a relation) depends on the identities of all the other ones. This scenario is repeated with any kind of objects and their appropriate relational modes, and it always ends up with a substance that monists call '*One*'.

However, such a framework is not friendly to structuralism. The fundamental building blocks of reality are, according to structuralists, relations, but we have learned that these are mere aspects of something more fundamental. Another important ingredient of OSR is extrinsicality, but this ingredient is lost because every mode is an *intrinsic* mode of the *One*. Nevertheless, defenders of monism may argue that relations and extrinsicality can find their place among the parts of the *One*. Question is whether monists can admit such a dualistic ontology of the *One* and the *One's* parts. Which entity would then be fundamental – the *One*, its parts, or both? If the *One*, then relations and extrinsicality can't be fundamental as structuralists require, because they would be related to ontologically inferior entities (*One's* parts). If the *One's* parts are fundamental, then the monistic frame-

work would be replaced by a pluralistic ontology. The same happens if the *One* and its parts are put on a par because there would be a plurality of fundamental entities, which contradicts monistic views as well. As a result, monistic ontological inventory may include just one particular with its monadic properties, and the individuation of the *One's* parts, if possible, can't be an individuation of something that is, in ontological terms, on the same footing with the *One*. This means that extrinsicality and relationality can't be fundamental ingredients of monism, which is a serious obstacle to couple monism with OSR.

Nevertheless, monism can accommodate relations and relata by giving up numerical diversity (which is impossible to accomplish) in favour of heterogeneity. According to this line of thought, relata would be still numerically identical, but qualitatively different. This approach appeals to the plurality of properties that the *One* bears or instantiates *locally* (Schaffer 2010, 59 – 60): different regions of the *One* either instantiate (if the properties are universals), or bear (if the properties are tropes) qualitatively different properties. However, it is disputable whether this account adequately meets the requirements of the structuralist ontology. Consider properties as universals. Extrinsicality and relations would then be grounded in universals that the *One* instantiates, but this would lead to the conclusion that relations are mere formal, second-order attributes of the *One's* first-order properties. Obviously, formal entities can't fulfill the role that Esfeld assigned to dispositional relations – block underdetermination and accommodate causation. Situation differs in case of tropes because tropes can be regarded as unproblematic causal relata. Question is whether this view is satisfactory to monists. The worry is that tropes are particular-like entities whose acceptance leads to pluralistic ontology; monists can't accept the existence of numerically distinct particulars. In conclusion, even a weaker requirement of grounding relations and extrinsicality to heterogeneity of the *One* is not in accord with structuralism. Something similar holds for causation. If there are any causal relations within the monistic framework, then their relata are numerically one and the same entity. Literature recognizes this form of causality as immanent causation. Although immanent causation is

admitted in some cases,[8] rendering *every* causal effect immanent is rather unorthodox. Even the assumed existence of the *One's* parts (e.g. spatial) is insufficient to accommodate causation in Esfeld's sense. As we already know, the *One's* parts, whatever they are, are not on a par with the *One*. This fact would undermine Esfeld's view of causation as an essential feature of fundamental structures. Grounding causation to numerically identical but heterogeneous relata (the *One's* distinct properties) doesn't work either. If the heterogeneity is based on universals, then causation becomes a formal, second-order relation between the first-order properties of the *One*. But formal attributes, unlike causal, don't produce detectable effects. Heterogeneity based on tropes is satisfactory in regard to causation (causation as an interaction between tropes), but disappointing in relation to monism. As has been explained, tropes, as particular-like entities, bring ontological plurality that contradicts monistic principles.

More importantly, monistic ontology is disqualified by its inadequate approach to fundamental physical properties. Fundamental properties are local in the sense that, for instance, a charge of *this* particular electron repels or attracts a charge of *that* particular electron. Their causal influence is based on strictly singular facts – it is an *intrinsic* relation between the properties.[9] Differently put, causal interactions between fundamental particles cannot be global and, therefore, monists are wrong when they say that every fundamental fact is a global fact of the world (Sider 2007, 5 – 6). Thus the monistic framework includes a disputable picture of fundamental properties and this, I think, is the price that structuralists, in regard to scientific realism, are not likely to pay.

Fundamental physical properties are a threat to moderate OSR in yet another sense. They undermine the structuralist argument against intrinsic properties (discussed in the first paragraph). Let us return to electrons. An electron is charged intrinsically (independently of its environment), and yet this power is detectable due its manifestations in causal interactions. For this reason, some intrinsic properties *can*

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[8] Especially in relation to temporal persistence, see Zimmerman (1997).

[9] Causal interactions of this type are labelled as "singularist"; see Zeleňák (2008, 80 – 82).

and *must* be accepted by scientific realists, but this is what the argument against intrinsic properties was supposed to block. To follow M. Dorato's example (Dorato 2006, 143), dispositional/categorical distinction differs from relational/intrinsic distinction: relational does not mean dispositional and intrinsic does not mean categorical. If he is right, and I believe he is, then Esfeld's appeal to relational ontology does not automatically guarantee the existence of causal/dispositional structures, nor *vice versa*.

Meanwhile, Esfeld has changed his opinion about fundamental properties and now admits that they are indeed intrinsic.[10] Surprisingly, he does not consider this concession dramatic and believes that OSR can survive it almost intact. He claims that fundamental properties would undermine moderate OSR only if they contribute, as intrinsic properties, to the identities of their bearers. In that case, structural identity conditions would be thrown away and moderate OSR would accept object ontology because the knowledge of objects would require the knowledge of intrinsic properties. But this may not happen, and Esfeld is right, because objects are indiscernible in regard to physical fundamental properties they bear or instantiate. For instance, electrons are indiscernible in respect to their charge because, loosely speaking, they all share the same negative charge. Although this partial tolerance to intrinsic properties may become a strong weapon in the hands of Esfeld's opponents, there is another reason why moderate OSR (with dispositional relations) should accept it.

Dispositions may not be manifested, and the same holds for dispositional relations. It is then conceptually possible to have an object whose extrinsic properties are not, currently, manifested because it is not under a relevant stimulus. As a result, a given object does not manifest its modes, does exist outside relations, and thus becomes a mysterious undetectable.[11] In order to avoid this, moderate OSR should stipulate that *some* dispositional relations are necessarily manifested, but this would be a rather controversial proposition. A partial fix comes from fundamental physical properties because they manifest their powers spontaneously, outside relations, as they do not need

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[10] This shift has been indicated in an e-mail exchange.

[11] I owe this point to F. Huoranszky and H. Ben-Yami.

triggering conditions (Dorato – Esfeld 2010, 8 – 9).[12] If isolated entities exemplify such properties, then they are indeed detectable. On the other hand, since fundamental physical properties are not relational, they do not prevent their isolated bearers from losing structural identity conditions, and this is in sharp contrast to moderate OSR's view of objects. Its defenders can only respond by either saying that isolated entities are *empirically* impossible, or by limiting the scope of their theory.

Conclusion

As we have seen, essential features of moderate OSR include (1) objects with structural identity conditions, (2) causal/dispositional relations, (3) inseparability of objects from relations and, finally, (4) exclusion of intrinsic properties (with the exception of fundamental physical properties). This repertoire, however, contains several tensions. Their main source is (3) because it implies radical monism. But (3) cannot be avoided because it prevents objects from becoming mysterious undetectables that would introduce ontological underdetermination. It seems that problematic monism can be consistently rejected only if objects are denied. Then, however, we confront objectless structures of radical OSR and this is what Esfeld tries to avoid. An ideal solution would consist of keeping objects tied to dispositional relations, but preventing ontological dependence from spreading throughout the entire structure.[13] In this sense, moderate OSR requires further refinements.

[12] The page number refers to the reprint.

[13] For instance, replacing monism with an acceptable holistic framework.

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