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What is Really Wrong with Ontic Structural Realism? On the Possibility of Reading off Ontology from Current Fundamental Science

Ontik Yapısal Gerçekçiliğin Asıl Problemi Nedir? Güncel Temel Bilimlerden Ontoloji Okunması Olasılığı Üzerine

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Abstract: I argue that the central conflict between epistemic and ontic versions of structural realism concerns whether it is possible to read off ontology from current fundamental science. Even if we assume that structures are metaphysically superior to objects, the possibility of reading off ontology from current fundamental science remains unjustified. I show that the conclusion as regards the reading off ontology in the ontic version is already assumed in one of the premises; hence the argument begs the question. As a result, the problem of ontological discontinuity implied in the pessimistic meta-induction argument remains intact in ontic structural realism.

Keywords: Structural realism, theory change in science, reading off ontology from science.

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1. Structural Realism: The Fundamental Conflict

Worrall 1989 introduced a structuralist position in the philosophy of science regarding the tension between no miracle (NMA) and pessimistic meta-induction (PIA) arguments. He agrees with the proponents of PIA such as Laudan (1981, 1984) that the introduction of "approximate truth" does not protect scientific realism from the destructive effects of the ontological discontinuity implied in PIA. However, endorsement of such an argument does not necessarily mean that the realism should be abandoned altogether. If we epistemically commit ourselves to the mathematical or structural part of theories and reveal a continuity regarding this structural part across theory changes, then ontological discontinuity throughout radical theory changes in the history of science would not pose a serious threat to realism. In such a formulation, our lack of epistemic access to the "blueprint" of the world and the subsequent ontological discontinuity makes any *reading off ontology from current science* impossible.

Some structuralists, however, have taken this restriction on the ontology problematic. Ladyman 1998 separates his ontic version of structural realism (OSR) from Worrall's epistemic one (ESR) by arguing that metaphysics cannot be a restricted area for a realist. The upshot of the argument is that we should replace our object-based ontology with a structuralist one. If objects are eliminated in favour of structure, then ontological discontinuity would disappear. For, fundamental ontology consists of structure only, and so long as we can show continuity at the structural level, we can show the continuity of primary constituents in our ontology. Ontological discontinuity endorsed by Worrall is just a delusion since theoretical entities responsible for the discontinuity are eliminated in favour of structure. Therefore, according to OSR, *reading off ontology from current fundamental science is possible*, and the correct reading is that objects are dissolved into the structure at the fundamental ontological level. So, the central conflict between epistemic and ontic versions of structural realism, in my opinion, concerns whether it is possible to read off ontology from current fundamental science.

It has been taken granted in the literature that any argument emphasising the ontological priority of structures over objects would

vindicate OSR. However, metaphysically superiority of structures over objects might not be sufficient to justify the possibility of reading off ontology from current fundamental science; in which case the ontological discontinuity argument remains intact. Before I further explain what I mean by that, in the next section, I provide details of the argument for the ontological priority of structures over objects.

2. On the Ontological Priority of Structures over Objects

It has been argued that quantum statistics differs from the classical one in the number of different arrangements (permutation) of particles over states in such a way that quantum particles would violate Leibniz's principle of "Identity of Indiscernibles" (PII) [1]. In addition to quantum statistical concerns, it has been argued that entangled quantum states also support the ontological priority of structures[2]. In a singlet state of two entangled electrons, their spins in any given direction are opposite to each other, but each particle itself does not have a definite spin in any direction. Hence there is the dilemma that either quantum particles are not individuals, or they have transcendental individuality, such as haecceity. Saunders 2003a, 2003b, 2006 argue that there is no such dilemma since entangled particles are "weakly discernible", in such a way that Leibniz's PII would not be violated. Such a weakened form of discernibility applies to fermions that satisfy irreflexive relations. Saunders' argument here is that PII entails that if a relation is irreflexive, in the form aRb, then "a" and "b" are distinct relata. Notice that what makes particles weakly discernible is the asymmetric, irreflexive nature of the relation that particles bear to each other. In other words, it is the nature of relation itself that enables attributing weak discernibility to relata. This emphasis on the relation itself, according to Ladyman and Ross, is sufficient to argue that the relation has an ontological priority over the relata: "it is possible to regard all facts about the identity and diversity of them [fermions] as supervenient on facts about the relations into which they enter, suggesting at least that relations are primary to things" (Ladyman and Ross, 2007, 152).

[1] French and Redhead 1988 is the classical paper in the literature. See also French 1989, 1998, 2014, and van Fraassen 1991.

[2] See Esfeld 2004 for the relation between entangled quantum states and OSR.

Although quantum particles lack the attributes to qualify as individuals, Ladyman and Ross clearly state that they are not eliminativist about objects: "there are objects in our metaphysics but they have been purged of their intrinsic natures, identity, and individuality, and they are not metaphysically fundamental." (Ladyman and Ross, 2007, 131) However, although their ontology is not eliminativist, relations are ontologically prior to relata since "the relata of a given relation always turn out to be relational structures themselves on further analysis" (Ladyman and Ross, 2007, 155). The crucial idea here is that "real patterns" have ontological priority over the individuals[3]. Ladyman and Ross take results of science, as it is practised by scientists, as metaphysically definitive. Since the ontological status of quantum particles is not a serious concern for practical scientists, the discussion is metaphysically deflated (see e.g. Ladyman 2016, 202). The debate over the elimination of quantum particles, therefore, would be mere metaphysical speculation. The crucial point, from a naturalistic point of view, is whether we can talk about quantum particles in "law-like/causal" regularities, where these regularities are understood as real patterns that do not supervene on any self-subsistent individual.

Ontological priority of relations over relata, however, is not common among all versions of OSR. In Esfeld and Lam's "moderate" version (2008), for instance, objects are ontologically on a par with relations. In this view, relata have fundamental significance together with relations because it is formulated in a Bohmian framework. The very possibility of the individuality of quantum particles, therefore, might be underdetermined by the interpretation of quantum mechanics that one endorses. Some think that quantum particles are individuals and the metaphysical underdetermination about their individuality is deeply flawed in Bohmian interpretation (see e.g. Belousek, 2000a, 2000b). So, the individuality of elementary quantum particles discussion might be inherently related to the interpretation of quantum mechanics. According to Ladyman and Ross, however, "QFT and the standard model incorporate symmetry groups and use them to arrive at empirical predictions for particle families that are completely independent of a solution to the measurement

[3] The term "real pattern" is due to Dennett 1991.

problem." (2013, 135) In other words, measurement problem in quantum mechanics might be a serious problem, but that should not refrain us from deriving metaphysical conclusions from other well-established parts of the theory. As a response, it might be argued that measurement problem is so central to quantum mechanics that any metaphysical account of individuality of particles would be affected by the preferred interpretation of the theory[4]. Without taking any part in this dispute, I just assume, for the sake of the argument, that advocates of OSR have some legitimate reasons to argue for the ontological priority of structures over objects without mentioning a solution to the measurement problem. The question then, concerning the fundamental conflict between OSR and ESR that I mentioned in the first section, is the following one: does establishing the priority of structures over objects solve the ontological discontinuity problem implied in the pessimistic meta-induction argument? Next section discusses a negative answer for this question on the basis of a realist interpretation of entanglement in quantum information theory.

3. Are there Just Structures "All the Way Down" if the Ontological Priority for Structures Argument Holds?

Jeffrey Bub argues that Clifton-Bub-Halvorson (CBH) 2003 formulation of quantum information theory (QIT) has an ontological conclusion: entanglement could be introduced as a new physical entity on its own right, in the sense that it does not supervene on any other ontologically superior physical source. This new formulation, Bub argues, suggests that we should reconceptualise our understanding of QM in the following

[4] See Esfeld 2013 for an argument that if OSR cannot explain how structures are implemented or instantiated in nature by favoring a particular interpretation of quantum mechanics, then the difference between concrete-physical and abstract-mathematical structures is left unexplained, in which case OSR would remain as a version of incomplete realism like ESR. As regards to the difference between physical and mathematical structures, van Fraassen 2006 argues that anything introduced to explain the difference would be more fundamental than the structure itself, which would be at odds with the slogan that structure is all there is at the fundamental level. Ladyman and Ross' reply to this is that "[t]he 'world-structure' just is and exists independently of us and we represent it methematico-physically via our theories" (2007, 158), and so long as we can do that, an additional argument explaining *how* mathematical and physical structures differ is not required. Humphreys (see Stanford et al. 2010) dubbed this denial of the need for an explanation for the difference as "intellectual evasion".

way: "a quantum theory is best understood as a theory about the possibilities and impossibilities of information transfer, as opposed to a theory about the mechanics of nonclassical waves or particles." (Bub, 2004, 242) According to this reconceptualisation, field-theoretical debate whether particles or fields should be understood as the ontological primitive, for instance, wouldn't have any fundamental importance anymore since our focus is shifted to the entanglement. To show this new fundamental role of entanglement, Bub mentions Einstein's distinction between "principle" and "constructive" theories. Special theory of relativity and QIT are both principle theories. The field is introduced in the special theory of relativity as a new ontological primitive in the sense that it does not ontologically depend upon any other physical stuff. Likewise, entanglement in QIT should be understood as a new physical primitive (Bub, 2005).

Bub's argument highlights the possibility that the fundamental ontology that could be read off from the QFT may not be the same as the ontology that could be read off from QIT. If we agree with Bub on taking entanglement as the new physical primitive in the sense that it does not supervene on any other ontologically fundamental physical source, then proponents of OSR should show how to eliminate this new physical primitive in favour of structure. For, even if we assume the successful elimination of particles, entanglement remains as another ontological primitive at the fundamental level; hence structure all the way down argument fails.

Here, proponents of OSR can insist that Bub's interpretation attributing an independent ontology to the entanglement does not give any harm to their argument. They might either argue that relations are much fundamental than the entanglement, or that entanglement cannot be introduced as a new fundamental physical source. If they choose the former path, the claim would be absurd since the entanglement is the relation itself. If they go for the latter option, then the claim that entanglement is eliminated in favour of structure would require a separate argument. If there is no separate explanation for this claim, but we are expected to accept it without any further justification, then structure all the way down argument would be trivialised. For, proponents of OSR might use the argument that "X is eliminated in favour of structure" for

any theoretical entity X that will be introduced as new physical primitive in any future physics. The argument for the elimination of quantum objects is based upon permutation concerns of particles in quantum statistics in the early years of quantum mechanics, and entangled quantum particles later on. OSR would need a similar separate argument for the elimination of entanglement to get rid of the treat that Bub's interpretation poses. However, I assume at this point once again that advocates of OSR might somehow show that Bub's argument does not give any harm to their position. Even in that case, I argue in what follows, there is a much more fundamental problem with OSR.

4. Reading off Ontology from Current Fundamental Science

Notice that the locus in previous arguments is the philosophy of physics. The discussion is about whether quantum particles possess individuality, or about whether entanglement could be eliminated in favour of structure. Both sides assume that *it is possible to read off ontology from current science*. Although they disagree on what the correct reading is, in other words, they disagree on what the fundamental constituents of the world are, they assume that reading off these fundamental constituents from current fundamental science is possible. This discussion is *intra-theoretical*: within a theory, opponents discuss metaphysical problems to find out the basic constituents of the fundamental ontology. However, ontological discontinuity argument that Worrall takes seriously is a problem concerning *inter-theoretical* relations between successor scientific theories in the history of science: given the fact that basic constituents of fundamental ontologies change across radical theory changes, how could reading off ontology from current fundamental science be possible? The OSRist solution here is that since theoretical entities causing ontological discontinuity are eliminated in favor of structures in modern physics, ontological discontinuity simply does not occur.

After I write down premises and conclusions of the arguments of both ESR and OSR in detail, I show in what follows that this solution actually is not a good one since the conclusion in the argument is included in one of the premises. Therefore, OSR's alleged solution begs the question.

First, ESR:

P (1): Pessimistic Induction Argument (PIA).

P (2): It is possible to show a structural continuity throughout theory changes.

P (3): No Miracle Argument (NMA).

C (1): We have structural knowledge of the world. (P2 & P3)

C (2): Reading off ontology from current science is not possible. (P1)

NMA concludes that there is a metaphysical determination relation between the theory and the world. However, exactly how this relation is established differs according to different versions of scientific realism. Structural Realism establishes this relation structurally: the structure of the theory latch onto the structure of the world. If we have this relation (P3), and at the same time, if we can show a structural continuity across theory changes (P2), then it is just natural to conclude that we do know the structure of the world (C1). However, although there is a structural continuity, there is a discontinuity at the ontological level due to the shifting ontologies across theory changes. Therefore, it follows from PIA (P1) that we do not have knowledge of theoretical entities; hence reading off ontology from current fundamental science is not possible (C2).

As for OSR, proponents endorse P (2) and P (3) in the argument of ESR; so their argument, too, entails C (1). As for P (1) in ESR, however, they reject it. OSR might be formulated in the following way, then:

P (1): No Miracle Argument (NMA).

P (2): It is possible to show a structural continuity throughout theory changes.

P (3): Structure is the only substance in the fundamental ontology.

C (1): We have structural knowledge of the world. (P1 & P2)

C (2): We know everything that could be known about the world (P3 & C1). Thus, reading off ontology from current science is possible.

OSR has been mostly criticised on the basis of P (3). However, recall that I assumed earlier that OSR could survive all these criticisms. The real problem, I would like to argue, is not about whether P (3) holds. Instead, the problem is about a hidden assumption it contains. The prob-

lem would be better revealed if this premise is rewritten as the following one:

P (3): Reading off ontology from current science is possible. And the correct reading is that structure is the only metaphysical entity in the fundamental ontology.

The problem is much clear now: C (2) is already assumed in P (3). A natural way of deciding which argument is more compelling would be looking for, first, the permissibility of each premises of each argument, and second, whether conclusions could be derived from the premises. However, in the argument of OSR, the conclusion under scrutiny is already assumed in one of the premises. So, OSR cannot show how reading off ontology from current fundamental science would be possible, hence does not solve the ontological discontinuity problem. Therefore, PIA is not addressed in OSR. French and Ladyman seem to understand Worrall as trying to provide a solution to PIA (see e.g. French and Ladyman 2003, 33). However, instead of trying to abandon PIA, Worrall's primary concern is to show that it does not necessarily disqualify NMA. According to anti-realists, PIA is so strong such that it refutes NMA. Realists, on the other hand, argue that NMA is the superior argument, undermining PIA. Worrall's structuralist suggestion at this point is that there is a third position where these two arguments do not exclude each other. PIA holds since there is an undeniable ontological discontinuity in the history of science. At the same time, however, the fact that the structure of the theory latches on to the structure of the world makes ontological discontinuity irrelevant in NMA. Therefore, PIA and NMA can peacefully coexist without excluding each other.

Conclusion

It might be argued that Worrall's suggestion is not convincing enough. One might question, for instance, his assumption about the structural continuity across theory changes in the history of science. However, it would be bizarre to argue that his position cannot provide a reply to PIA as he does not say he is offering a solution to the ontological discontinuity argument. Of course, providing a solution for PIA, on the top of showing structural continuity across theory changes, would make the

structuralism suggested by him stronger against competitive positions in the scientific realism debate. However, given what happened in the history of science, Worrall does not think this is possible. On the other hand, advocates of OSR claim that there is just structure all the way down argument provides a solution to PIA. That is not correct, as I have shown, since the argument begs the question.

Having said this, however, I would like to make it clear that OSR remains as a legitimate research program in the philosophy of physics. Modern physics is full of interpretative problems, and discussions about these issues might benefit a lot from OSR. The fact that OSR has been endorsed mostly by philosophers of physics shows that it touches upon some fundamental metaphysical problems of modern physics. However, in addition to the claim that OSR has a legitimate place within these discussions, if the proponents insist that their argument solves ontological discontinuity problem, and consequently declare superiority of their argument over ESR, that claim clearly does not hold.

References

Belousek, D. W. (2000a). Statistics, Symmetry, and the Conventionality of Indistinguishability in Quantum Mechanics. *Foundations of Physics,* 30, 1-34.

_____ (2000b). Statistics, Symmetry, and (In)distinguishability in Bohmian Mechanics. *Foundations of Physics,* 30, 53-164.

Bub, J. (2004). Why the Quantum? *Studies in the History and Philosophy of Modern Physics,* 35, 241-266.

_____ (2005). Quantum Mechanics is About Quantum Information. F*oundations of Physics,* 35(4), 541-560.

Clifton, R. & Bub, J. & Halvorson, H. (2003). Characterizing Quantum Theories in Terms of Information-Theoretic Constraints. *Foundations of Physics,* 33(11), 1561-1591.

Dennett, D. (1991). Real Patterns. *Journal of Philosophy,* 88, 27–51.

Esfeld, M. (2004). Quantum Entanglement and a Metaphysics of Relations. *Studies in History and Philosophy of Modern Physics,*

35, 601-617.

_____ (2013). Ontic Structural Realism and the Interpretation of Quantum Mechanics. *European Journal for the Philosophy of Science,* 3, 19-32.

Esfeld, M. & Lam, V. (2008). Moderate Structural Realism about Space-time. *Synthese,* 160, 27-46.

French, S. (1989). Identity and Individuality in Classical and Quantum Physics. *Australasian Journal of Philosophy,* 67, 432-446.

_____ (1998). On the Withering away of Physical Objects. *Interpreting Bodies: Classical and Quantum Objects in Modern Physics*. (Ed. E. Castellani). Princeton: Princeton University Press, 93-113.

_____ (2014). *The Structure of the World: Metaphysics and Representation.* Oxford: Oxford University Press.

French, S. & Ladyman, J. (2003). Remodelling Structural Realism: Quantum Physics and the Metaphysics of Structure. *Synthese,* 136, 31-56.

French, S. & Redhead, M. (1988). Quantum Physics and the Identity of Indiscernibles. *British Journal for the Philosophy of Science,* 39, 233-246.

Ladyman, J. (1998). What is Structural Realism? *Studies in the History and Philosophy of Science,* 29, 409-424.

_____ (2016). Are There Individuals in Physics, and if so, What are They? *Individuals Across Sciences.* (Ed. A. Guay). Oxford: Oxford University Press.

Ladyman, J. & Ross, D. (2007). *Every Thing Must Go: Metaphysics Naturalized*. Oxford: Oxford University Press.

_____ (2013). The World in the Data. *Scientific Metaphysics.* (Ed. D. Ross, J. Ladyman & H. Kincaid) Oxford: Oxford University Press.

Laudan, L. (1981). A Confutation of Convergent Realism. *Philosophy of Science,* 48(1), 19-49.

_____ (1984). Discussion: Realism Without the Real. *Philosophy of Science,* 51, 156-162.

Saunders, S. (2003a). Indiscernibles, General Covariance, and Other Symmetries. *Revisiting the Foundations of Relativistic Physics: Festschrift in Honour of John Stachel.* (Ed. A. Ashtekar, D. Howard, J. Renn, S. Sarkar & A. Shimony). Dordrecht: Kluwer.

_____ (2003b). Physics and Leibniz's Principles. *Symmetries in Physics: Philosophical Reflections*. (Ed. K. Brading & E. Castellani) Cambridge: Cambridge University Press.

_____ (2006). Are Quantum Particles Objects? *Analysis,* 66, 52–63.

Stanford, K. & Humphreys, P. & Hawley, K. & Ladyman, J. & Ross, D. (2010). Protecting Rainforest Realism, Symposium. *Metascience,* 19, 161-85.

Van Fraassen, B. C. (1991). *Quantum Mechanics: An Empiricist View*. Oxford: Oxford University Press.

_____ (2006). Structure: Its Shadow and Substance. *British Journal for The Philosophy of Science,* 57, 275-307.

Worrall, J. (1989). Structural Realism: The Best of Both Worlds? *Dialectica,* 43, 99-124.

Öz: Epistemik ve Ontik Yapısal Gerçekçilik arasındaki temel ayrımın güncel temel bilimlerden ontoloji okunabilirliği ile alakalı olduğu iddia edilmektedir. Ontolojik bağlamda, yapıların nesnelere nazaran daha temel olduğu kabul edilse bile güncel temel bilimlerden ontoloji okumasının gerekçelendirilemeyeceği iddia edilmiştir. Ontik Yapısal Gerçekçilik argümanındaki güncel temel bilimlerden ontoloji okumasıyla ilgili sonucun öncüllerin birinde mevcut olduğu, dolayısıyla sonucun kanıtlanmış varsayıldığı gösterilmiştir. Sonuç olarak, karamsar indirgemeci argumanda ima edilen ontolojik süreksizlik problemine Ontik Yapısal Gerçekçilik'te değinilmemektedir.

Anahtar Kelimeler: Yapısal gerçekçilik, bilimde kuram değişimi, temel bilimlerden ontoloji okuma.