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DISCUSSION

A POSSIBLE ANSWER TO NEWMAN'S OBJECTION FROM THE PERSPECTIVE OF INFORMATIONAL STRUCTURAL REALISM

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Abstract. This paper aims to reconstruct a possible answer to the classical Newman's objection which has been used countless times to argue against structural realism. The reconstruction starts from the new strand of structural realism – informational structural realism – authored by Luciano Floridi. Newman's objection had previously stated that all propositions which comprise the mathematical structures are merely trivial truths and can be instantiated by multiple models. This paper examines whether informational structural realism can overcome this objection by analysing the previous attempts to answer this objection, attempts which either try to save the ramseyfication of mathematical propositions or give up on it. The informational structural realism way is to attempt a third way, the neo-Kantian way inspired by the work of Ernst Cassirer, but also to change the formalism from a mathematical to an informational one. This paper shows how this original combination of neo-Kantianism, informational formalism and the method of levels of abstraction provide the tools to overcome Newman's objection.

Key words: structural realism, information, Luciano Floridi, Newman's objection, ramseyfication, levels of abstraction, model theory, philosophy of information.

1. INTRODUCTION

The purpose of this paper is to examine whether Luciano Floridi's Informational Structural Realism (ISR), one of the newest theories belonging to the structural realist paradigm, is able to overcome one of the major objections brought to the classical versions of structural realism. The main question to ponder is whether the ISR is a better alternative to the classical flavours of structural realism such as the epistemic and ontological ones. Such a question of value cannot be answered unless we set up from the start a theoretical test that should ground the objectivity of our quest. The most difficult problem for any type of structural realism is overcoming the Newman Objection which, arguably, has not received a

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satisfactory answer so far. Newman's objection has been the greatest theoretical diffficulty faced by structural realists so far in their attempt to make structural realism the mainstream approach in the philosophy of science. Therefore the focus of this paper is to find out whether Floridi's ISR can find an answer to the objection and face the challenge that has sunk a thousand structural realist ships. The current paper is an exploration into an uncharted territory, because Luciano Floridi has not yet written anything extensive about the answer to the Newman objection from the ISR perspective.

The current paper is divided into the following sections: first a brief explanation of what the 'classical' structural realism theories propose, then follows an explanation of the novelty of ISR, after which a description of the Newman objection and its major difficulty for any structural realist theory are offered. Next, the current answers given to the Newman objection from 'classical' structural realist standpoints are examined, and finally the reconstruction of a possible ISR answer to Newman's objection is proposed.

2. STRUCTURAL REALISM

Structural realism is a relatively new theory in the philosophy of science, having gained the attention of the philosophers of science in the latter half of the twentieth century. Structural realism distinguishes itself from the other types of realism by stating that there are invariant structures among scientific theories and that these structures can survive paradigm shifts. In other words, a belief in the progress and continuity of science motivates the structural realist, but this belief is not simply in the truth of scientific propositions, but in their underlying mathematical structures which seem to remain unchanged.

The first proponents of structural realism were a philosopher and a mathematician, Bertrand Russell and Henri Poincaré respectively. In 1912 Bertrand Russell was positing a proto-form of structural realism in his work *The Problems of Philosophy* where he was stating that we can know only spatial relations between objects, but not the objects themselves:

> Thus we find that, although the relations of physical objects have all sorts of knowable properties, derived from their correspondence with the relations of sense-data, the physical objects themselves remain unknown in their intrinsic nature, so far at least as can be discovered by means of the senses.[1]

Russell's idea was going to be later classified as epistemic structural realism (ESR) because it implies a minimal ontological engagement with the structures,

[1] Bertrand Russell, *The Problems of Philosophy* (1912), accessed November 21, 2013, http://www.gutenberg.org/ebooks/5827, 17.

stating that we can only know the structures found in scientific theories, but not the entities which appear in the relations on which these structures are predicated.

In 1927 Russell continued his structural program by publishing *The Analysis of Matter* where he proposed the approach of reconstructing scientific knowledge instead of reducing knowledge to descriptions. A year later, M. H. Newman was responding to Russell in an article published in the *Mind* journal in which he raised the so-called Newman's objection. His objection acted as a stopping point for Russell's programme because Russell admitted that he found no answer to such a serious objection. Following Russell, Arthur Eddington and Ernst Cassirer took up the challenge of supporting structural realism. According to Statis Psillos, it appears that also Rudolf Carnap supported a form of structural realism in his later philosophy. But all these attempts did not make structural realism a serious contender in the philosophy of science at that time. It was only in the 1960s when Grover Maxwell resuscitated the attention for scientific realism that structural realism also came back on stage. Starting from the 1990s until now there has been a flood of articles concerning structural realism which goes to show that at this moment structural realism is one of the most debated and most important theories in the contemporary philosophy of science.

Currently, most contemporary philosophers who subscribe to structural realism support either epistemic structural realism (ESR), ontological structural realism (OSR) or a modified version of these two. ESR states that structures are the only thing we can know for sure, while the OSR will state that structures are the only entities we can commit to ontologically. The main advantage of structural realism is that it is able to overcome one of the classical objections brought to scientific realism, the pessimistic meta-induction. This objection states that many scientific theories were falsified in the past and therefore we have no reason to believe that our current theories will not be falsified in the future. The structural realist answers to this objection by showing that there is a structural continuity between the old and the new theories. But how is this continuity to be explained? According to Ernst Cassirer, the old theories with empirical content are not rejected, but included as special cases of the new theory. Another explanation, belonging to John Worall, is that there is a strong theoretical nucleus which survives and is passed on from the old theory to the new one.

One of the major theses of structural realism is that the identity of a scientific theory is not given by the set of propositions that the theory accepts as true, because the falsification of one proposition would collapse the entire theory. It is rather the underlying structure which gives the identity of the scientific theory. These structures are mathematical, hence structural realism applies only to sciences which allow mathematisation but also have an empirical nature, namely only to physics so far. The main advantage of subscribing to the continuity of mathematical structures among theories is that the nucleus of the theory is not vulnerable to experimental falsifications because the nucleus is not comprised of empirical statements. The main disadvantage however is that the structural realist needs to subscribe to an ontology of mathematical objects which is quite strange for any realist because, at the end of the day, scientific realism draws its roots from an empirical world-view. Being realist about mathematical structures is indeed an odd position and some philosophers might put the stamp of "idealism" on it. This is the paradox of structural realism and, as we shall see later, it is the main source for the Newman objection which draws heavily on a mathematical paradox.

3. INFORMATIONAL STRUCTURAL REALISM

Informational structural realism (ISR) tries to replace the mathematical formalism with an informational one and is, in a way, a paradigm change. IRS is part of a larger project of philosophy of information initiated by Luciano Floridi. In Floridi's system the main object of analysis is semantic information, defined as "well-formed, meaningful, and truthful data;"[2] while the method employed is the method of levels of abstraction. ISR is defined by Floridi in the following words:

> As a form of realism, ISR is committed to the existence of a mind-independent reality addressed by, and constraining, knowledge. ISR supports the adoption of LoAs [levels of abstraction] that carry a minimal ontological commitment in favour of the structural properties of reality and a reflective, equally minimal, ontological commitment in favour of structural objects. However, unlike other versions of structural realism, ISR supports an informational interpretation of these structural objects. This second commitment, in favour of structural *relata*, is justified by epistemic reasons.[3]

Thus, ISR is a 'minimal' ontology which is committed only to structural objects understood as informational objects. It is based on the idea that all we have are models of reality, and that in the scientific process we refine these models increasingly by incorporating more information. Thus, these models are "increasingly informative" about real-world relations, including the relations between the entities we cannot observe – which Floridi calls "sub-observables".[4]

In order to understand what is special about ISR, we need first to understand better the major difference between ESR and OSR according to Floridi. Floridi defines a structure S as being comprised of 4 sets:

1. a non-empty set O of objects (the domain of S),
2. a non-empty set P of first-order, one-place properties of the objects in O,
3. a non-empty set of relations R on O, and
4. a possibly empty set T of transitions rules (operations) on O.[5]

[2] Luciano Floridi, *The Philosophy of Information* (Oxford University Press, 2011), xiii.
[3] *Ibid*., 339.
[4] *Ibid*.
[5] *Ibid*., 342.

According to Floridi, ESR states that we can acquire knowledge only about the relations R, but not the properties P, while objects remain unknown.[6] There are two types of OSR, eliminativist and non-eliminativist, both subscribing to the existence of structures but diverging in the interpretation of the objects O. The main difference is that eliminativist OSR remains agnostic about the underlying objects O that are logically presupposed by structures. Non-eliminativist OSR states that we can know for certain something about these objects, namely that these have a structural nature.[7] Now we can understand ISR as a species of non-eliminativist OSR which is committed to informational objects. In other words, as explained by Sdrolia and Bishop, the ontological commitment of ISR "is phrased as a 'minimal ontological commitment' to 'structural objects' conceived as epistemic patterns or models of reality connecting the observer that constructs them with the world".[8]

To understand what is novel about ISR, we need to look only at the difference between mathematical objects and informational objects. Mathematical objects can be said to be a priori and eternal, whereas informational objects are constructed by the epistemic subject which constructs different models of reality according to the historical and cultural circumstances one lives in.

4. THE NEWMAN OBJECTION

In 1928 M. H. Newman published the article "Mr. Russell's Causal Theory of Perception" in the *Mind* journal. In this article he raised the famous Newman objection to Russell's structuralist theory which had appeared in his 1927 book *Analysis of Matter*. Newman's objection is mathematical in its source, but is has wide-encompassing metaphysical consequences for any structural philosophy. Here is a brief summary of the objection, following the reconstruction by Demopoulos and Friedman.

Assuming that in physics there are certain non-trivial statements, meaning that these are synthetically and a priori true, then it the problem is that the statements about the structural properties of physical theories are expressing only trivial truths.[9] For example, let us take the question whether matter is made up of atoms. The answer cannot be given by analysing the structural properties of a theory, but only by looking at the properties of the out-there world[10] because, says Newman, "this is a real question to be answered by consideration of the evidence,

[6] *Ibid*.

[7] *Ibid*., 344.

[8] Chryssa Sdrolia and J. M. Bishop, "Rethinking Construction: On Luciano Floridi's 'Against Digital Ontology'," *Minds and Machines* 24, no. 1 (2014): 90, doi:10.1007/s11023-013-9329-z

[9] William Demopoulos and Michael Friedman, "Bertrand Russell's The Analysis of Matter: Its Historical Context and Contemporary Interest," *Philosophy of Science* 52, no. 4 (1985): 627, http://www.jstor.org/stable/187446

[10] *Ibid*.

not a matter of definition."[11] This distinction between evidence and definition is at the basis of the split between mathematics and physics; there are different ways of discovery in the two related disciplines, mathematics discovers truth by analysis, while physics needs to explore empirical statements in order to find something. From this distinction derives the main core of Newman's objection.

Simply put, Newman's objection amounts to the idea that structural continuity among theories will render only trivial sentences about the number of elements in a set:

> the world consists of objects, forming an aggregate whose structure with regard to a certain relation R is known, say [it has structure] W; but of . . . R nothing is known . . . but its existence; . . . all we can say is There is a relation R such that the structure of the external world with reference to R is W.[12]

Because the same structure can be instantiated by multiple interpretations, it follows that a structure will not single out a unique theory or world. Bas van Fraasen has explained this idea in a more intuitive way:

> Suppose I have seven neighbors, and I insist that they instantiate a model M I have of a rigidly hierarchical social structure. This model M we can envisage as follows: it has seven elements and a 'directly under' relation. To visualize it, its elements are the general, directly under him two colonels, and directly under each colonel there are two majors. How can I say that my neighbors instantiate this hierarchical structure? To justify that I have to define a relation which has the same properties as the relation directly under has in my model. So I arbitrarily label my seven neighbors as follows: 1, 10, 11, 100, 101, 110 111. Then I define the relation as follows: neighbor 1 does not bear to anything; any neighbor with a label of form Y1 or Y0 bears to the neighbor labeled Y; and that is all.[13]

Similarly, Putnam's famous paradox is a refurbished version of Newman's objection. Putnam's paradox states that if the world is made up of an infinite number of objects, and if theory T is coherent and T states that there exists an infinite number of objects, then we only need to choose a model M with an infinite number of elements, then it follows that theory T will always be correct. T can have any non-contradictory axioms, what matters here is only its cardinality. The demonstration can be done with the Loewenheim–Skolem–Tarski–Vaught theorem, as shown by van Fraasen, as this theorem has shown that if a theory has one infinite model, than it has models of any infinite cardinality.[14]

[11] Newman, M. H. A., "Mr. Russell's "Causal Theory of Perception"," *Mind* 37, no. 146 (1928): 143, http://www.jstor.org/stable/2249202

[12] *Ibid*., 144.

[13] Bas C. van Fraassen, *Scientific representation: Paradoxes of perspective* (Oxford, New York: Clarendon Press; Oxford University Press, 2008), 219–20.

[14] *Ibid*., 230; see also Hilary Putnam, *Reason, truth, and history* (Cambridge [Cambridgeshire], New York: Cambridge University Press, 1981), 39–41.

P.M. Ainsworth has made an excellent summary and analysis of the responses given to Newman's objection over the time in the article "Newman's Objection" (2009). Ainsworth classifies the answers in two large classes, depending on whether these answers that keep or give up on ramseyfication. We remind the reader that ramseyfication of a sentence implies translating all the observational terms into theoretical ones. In his 1971 article "Structural Realism and the Meaning of Theoretical Terms", Grover Maxwell was proposing ramseyfication to be the formalism of choice for structural realism. For example, in the following formula ∀x([Ax&Dx] → ∃yCy) where Ax stands for the sentence "x is a Radium atom", Dx for "x is disintegrating" and Cx for "a nearby Geiger counter registers a pulse." We notice that A and D are theoretical predicates, while C is observational, therefore A and D must be ramseyfied, and we shall obtain the formula: ∃X ∃Y ∀x([Xx&Yx] → ∃yCy).[15]

For a structural realist, any scientific theory tells us about the world only what the Ramsey sentence of that particular theory can tell. Thus, it follows that we can only know about the world what we can express in sentences made up of logical and observational terms.[16]

Certain epistemic structural realists think that even the predicate C should be ramseyfied, because it refers to the world, and the "strong epistemic structural realists" – as Ainsworth calls them – think that only the terms which refer to internal perceptions should be left unramseyfied. Thus, we should end up with the following formula: ∃X ∃Y ∃Z ∀x([Xx&Yx] →∃yZy).

This formula is obviously empty of any meaning, because we can find many sets of three predicates which render the formula true, which was also the main point of the Newman objection.

Coming back to the types of answers brought so far to Newman's objection, Ainsworth has shown that both the answers that want to give up on ramseyfication and those who keep the ramseyfication have missed something essential from the initial objection, by reconstructing it differently.[17] After reading Ainsworth's article, the question about ramseyfication seems a dead end unless we take a third approach and argue that ramseyfication is not the crux of the matter, as Michela Massimi has done.

Massimi argues that Newman's objection affects only ESR which has been inherited from Russell, but not the structural realism with a neo-Kantian descendance coming from Poincaré or Cassirer. Her argument is that ESR maintains an externalist view on reference and therefore is vulnerable to any attack that would question this externalist view.[18]

[15] Grover Maxwell, "Structural Realism and the Meaning of Theoretical Terms," *Minnesota Studies in the Philosophy of Science* 4 (1971): 186.

[16] P. M. Ainsworth, "Newman's Objection," *The British Journal for the Philosophy of Science* 60, no. 1 (2009): 138, doi:10.1093/bjps/axn051

[17] *Ibid*., 148–50.

[18] Michela Massimi, "Structural Realism: A Neo-Kantian Perspective," in *Scientific structuralism*, ed. Bokulich, Peter Joshua Martin and Alisa Bokulich, Boston studies in the philosophy of science v. 281 (Dordrecht: Springer, 2011), 8–9.

Massimi argues that the main thrust of structural realism has never been about fixating the reference because this is not the function of the mathematical structures, "but rather as fixing the epistemic conditions under which we can reasonably and justifiably (albeit fallibly) make assertions about physical entities."[19]

To make this clear, Massimi illustrates this view with an example. Let us take the sentence 'the electron has momentum p'; for a follower of Russell, the main question would be how to find out the reference of the electron and the momentum, but a neo-Kantian would only ask what are the necessary conditions which would render this sentence true.[20]

Next, Massimi explains the epistemic conditions of assertability through a neo-Kantian understanding as "the good epistemic conditions, under which we are warranted to assert some sentences about unobservable physical entities, are given by a particular combination of experimental evidence and mathematical structures."[21] This view presupposes a certain 'layered' structure of the theory that would make it possible that from the most basically empirical level, the measurement level, the conditions of justified assertability are transmitted and kept through layers of abstraction until the layer of mathematical structures. In other words, an architectonic of science as the one proposed by Cassirer is needed in order to make this apparatus of justified assertability work. We remind the reader that it was Cassirer who showed that Einstein's theory of relativity did not in fact contradict Newton's physical model, but that Newton's theory is a special case of relativity.[22]

Is the neo-Kantian a satisfactory solution to Newman's objection? Not entirely. This type of answer leaves open an important part of the problem, namely how can a scientific theory be based on wrong assumptions about the world and contain non-existent terms at its most basic level (such as ether), while being true in its entirety. If the neo-Kantian conceives of a correct theory based on non-existent theoretical or observational terms, in other words, when we measure something which we cannot name, but all ends well in the higher levels of abstraction because the math works, then we need to subscribe to a coherence theory of truth. We should have then a set of sentences which all make sense and support each other, regardless of the outside world. But then we've lost the 'realism' in the structural realism because we have lost the reference to the real world. This reference stays in the measurement level, but we cannot explain how the conditions of justified assertability are transmitted up to the level of mathematical structures if the lower level sentences refer to non-existing entities.

The main point of Newman's objection was to show that by committing only to the mathematical truths in the physical theories, we are merely asserting trivial

[19] *Ibid.*, 10.

[20] *Ibid.*, 9–10.

[21] *Ibid.*, 11.

[22] Michael Friedman, "Ernst Cassirer," in *The Stanford Encyclopedia of Philosophy*, ed. Edward N. Zalta, Spring 2013 (2013), accessed July 16, 2014, http://plato.stanford.edu/entries/cassirer/

truths. We need to introduce somehow the actual world into this picture, or else all theories should be equally justified. The neo-Kantians tried to make a complex layer of levels where the empirical truths discovered through measurements give thrust to the mathematical structures at the higher levels. But it is very hard to show how exactly this move upwards is done. How does justification survive ramseyfication? I think that this move upwards from the empirical to the structural level deserves to be kept as a possible solution, but perhaps the formalism must be changed. This is where ISR enters the scene as a possible solution. Let us see next how.

5. A RECONSTRUCTION OF THE ISR ANSWER TO THE NEWMAN OBJECTION

Luciano Floridi has not written in detail about the Newman objection, though he mentions in a side-remark that there are certain types of structural realism which remain unaffected by the Newman objection such as Esfeld and Lam's moderate structural realism and his own ISR because these two do not make an ontological distinction between relations and relata. Let us try next to reconstruct how a detailed response of ISR to the Newman objection might look like.

First, by picking up on the obvious clue provided by Floridi, we should look at the moderate structural realism. What makes this theory invulnerable to Newman's objection? According to Floridi, it is the fact that this theory dispenses of set theory – the classical formalism used by ESR – and instead uses the model theory. As a reminder, model theory defines a proposition S through the class of its models Mod(S) meaning all the interpretations that make S true. A set T of propositions has the model Mod(T) the set of interpretations which stand as models for all propositions belonging to T, and it is said that T axiomatises the class Mod(T).[23]

The Russellian structural realism was vulnerable to the Newman objection because of its distinction among internal and external terms. This type of structural realism assumed that we have access to at least some parts of the world, namely to our inner senses, and if we can translate external terms into internal ones, than some empirical content will remain in the ramseyfied sentences. This empirical content would then be transferred to the non-observational terms which were defined though internal predicates and other observational terms. But if we were to follow a Kantian perspective, the world cannot be known in principle or, in Maxwell's words, "all of the external world, including even our own bodies, is unobserved and unobservable."[24] Then it should make no sense to distinguish anymore between the terms which describe the inner senses and the outer observational terms, because all are unobservable.

[23] Wilfrid Hodges, "Model Theory," accessed July 28, 2014, http://plato.stanford.edu/entries/model-theory/

[24] Grover Maxwell, "Scientific Methodology and the Causal Theory of Perception," in *Problems in the Philosophy of Science*, ed. Imre Lakatos and Alan Musgrave (1968), 152.

If we were to accept this "Kantian modesty,"[25] then the only distinction that we can use is the phenomenal/noumenal one. It is exactly this distinction among the phenomena which we can know and the unknowable noumena which underlies all types of structural realism and must be made clear, asserts Floridi.[26]

It follows from this that there are two possible types of relations which must be distinguished:

A) Phenomenal relations, which are formalised through n-places predicates and which can be ramseyfied. These relations occur only inside a model at a lower level of abstraction, like the measurement level.

B) Structural relations which appear at the higher level of abstraction, which is the level of conditions of possibility of any experience. The noumenal part of the theory survives in the first-order predicates used by the models found at the lower levels of abstraction because only these models claim to describe reality.[27]

The main feature which separates structural realism from instrumentalism is, according to Floridi, that it does not simply separate our knowledge from the real world, but instead makes "a cut" inside knowledge itself by distinguishing what we can know – namely the structural properties of a system – and "the explanations of its intrinsic properties."[28] The main advantage of this perspective would be that there is no such thing as a transparent relation between the world and the knowledge about it, but that all knowledge is mediated by the epistemic agents.[29]

There are two discernible levels of abstraction in the ISR framework: the level of knowledge (L_0) and the level of the conditions of possibility for this knowledge (L_1). L_0 is not uniquely determined because there are multiple scientific models competing at this level for the best explanation. Competing models can be divergent and exclusive and there is nothing stopping us from conceiving an explanatory model populated with bizarre entities such as angels, witches, unicorns and phlogiston. But there is one methodological restriction imposed by Floridi, which is to illustrated by Occam's razor and not postulate unnecessary entities.[30] The main advantage of distinguishing the levels of abstraction is that it allows to the epistemic agents to limit their ontological commitment only to the entities that are conceivable at that level. After the epistemic agents analyse a certain system and build models of it at level L_0, then the philosopher or scientist can identify the structures which make L_0 knowledge possible, and posit these structures at the level L_1.[31]

We have obtained thus a scientific theory which is composed of the levels of abstraction, the models constructed by the epistemic agents, and the structures

25 Floridi, *The Philosophy of Information*, 342.
26 *Ibid*., 346.
27 *Ibid*., 364.
28 *Ibid*., 347.
29 *Ibid*.
30 *Ibid*., 349.
31 *Ibid*., 350.

identified, but the theories do not tell us anything directly about the world at hand, only about how the epistemic agent understands this world. The ontological commitment is done when choosing the level of abstraction L_0 which will impose a limit on the number and type of entities included in the model.[32]

ESR stays at this lower level of abstraction, namely L_0 and accepts only the ontological commitment to properties. But how can we ontologically commit to structures themselves? We need to go up a level, at L_1, where the conditions for the possibility of knowledge are stated. Thus, analysing L_1, we should conclude that structural knowledge is possible only if structural objects exist. At L_0 we could infer only a trivial knowledge of the number of types of objects, but at L_1 we know the types of structural entities. In order to have structural knowledge at all at level L_0, we need structural objects to exist at all in the system analysed thus far.[33]

The next move that Floridi makes is to postulate that these structural objects are actually informational objects. This is perhaps the most interesting move so far because it helps us close the neo-Kantian gap between levels of abstraction in the architectonic of science. The problem with the neo-Kantian approach was how to carry upwards the empirical weight of the measurements into the abstract mathematical structures. By changing the formalism from mathematics into information theory, Floridi succeeds in doing just that. We remind our readers that information is a function of a probability, and there are infinite degrees of information contained in diverse propositions. The fact that a proposition is true or false does not render anything but a trivial knowledge; but how much information does a proposition hold – this is not a trivial matter. In other words, there are degrees of truth in any system of propositions and this degree can be captured only by measuring the quantity of information. The information obtained at the lowest level of abstraction, be it through measurements or other means, is the base for the informational objects that make up the level L_1. Information is not lost among the levels, just encapsulated differently and thus we can say that the empirical base, the real-world link has not been lost. The informational objects that are the structures posited by the ISR are not empty, they contain the conditions of possibility which make meaningful the information discovered by the epistemic agents at level L_0.

To sum up, there are two types of partially successful answers to the Newman objection. The first one, illustrated by the moderate structural realism of Esfeld and Lam, tries to change the formalism by giving up on predicates and favouring only relations. This answer has certain flaws such as not being to make the distinction between essential relations and marginal ones. Then there is the second, neo-Kantian answer, which disentangles the structures from their referential burden and evaluates these only from the perspective of the justified assertability conditions. This approach has certain problems such as that it presupposes an architectonic of science which can be based on the shaky ground of non-existent terms while maintaining that the structures built on these are true.

[32] *Ibid.*
[33] *Ibid.*, 352.