Workshop

Non-Causal Explanations: Logical, Linguistic and Philosophical Perspectives

Book of abstracts

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Abstracts

Invited speakers

Hannes Leitgeb

HYPE and Possible States Semantics

This talk will extend the system HYPE of hyperintensional logic and semantics to a possible-states-semantics for various kinds of modalities, including (one type of) grounding.

Erik Weber

Against 'Distinctively Mathematical' Explanations of Physical Facts.

In the literature on mathematical explanation it is common to distinguish between intra-mathematical explanations (mathematical explanations of mathematical facts, such as theorems) on the one hand and extra-mathematical explanations (mathematical explanations of physical facts) on the other hand. The latter are thought to be 'distinctively mathematical' in the sense that mathematics plays a special role in them, a role that goes beyond the role mathematics plays in 'standard' explanations of physical facts. Philosophers who have claimed that there are distinctively mathematical explanations include Alan Baker, Robert Batterman, Marc Lange and Aidan Lyon. Popular examples include pitfalls with respect to the distribution of twenty-three strawberries, the crossing of the seven bridges of Königsberg and the disentangling of trefoil knots.

I distinguish three possible theses about these explanations:

-*Existence Thesis*

There are legitimate explanations of physical facts that are distinctively mathematical.

-*Uniqueness Thesis*

There are physical facts for which the only legitimate explanation is a distinctively mathematical one.

-*Superiority Thesis*

There are physical facts for which the best available explanation is a distinctively mathematical explanation (i.e., there is a standard physical explanation, but that is not the best one).

This paper argues against these theses.

Francesca Poggiolesi

When grounding meets proof-theory

The concept of grounding has a long and venerable history that starts with Aristotle and continue through philosophers such as Ockham or Bolzano. Quite recently we assist to an impressively flourishing and increasing interest for the notion of grounding, which is studied and analyzed from many different angles. Amongst them, scholars have been trying to capture the structural and formal properties of the concept in question by proposing several logics of grounding (e.g. see Correia (2014), Fine (2012), Korbmacher (2017), Schnieder (2011)). In these logics grounding is formalized either as an operator or as a predicate. The main aim of this talk is to present a different approach to the logic of grounding, which stems from some deep Bolzaian intuitions and where grounding is formalized as a meta-linguistic relation (i.e. see Poggiolesi (2016, 2018)), just like the notion of derivability or that of logical consequence. Let me call such an approach LG. The central characteristics of LG can be resumed in the following list :

- LG allows a rigorous account of ground-theoretic equivalence.

- In LG grounding rules are unique; in particular it is possible to formulate an unique grounding rule for negation.

- Finally LG allows to prove important results such as the soundness and completeness theorems, but also the deduction theorem at the grounding level.

Contributed Talks

Dingmar van Eck

Design explanation through mechanist idealisation

Whereas idealisation is part and parcel of scientific mechanistic modelling, idealisation in the philosophical literature on mechanistic explanation has garnered scant attention. We seek to add momentum to this important (but underdeveloped) line of research by elaborating two (related) explanatory functions of idealisation in mechanistic models and mechanistic model-based (non-causal) design explanations as used in systems biology. The first function concerns explaining the presence of structural/organizational features of mechanisms by reference to their role as difference-makers for performance requirements. The second concerns tracking counterfactual dependency relations between features of mechanisms and features of mechanistic explanandum phenomena. To make these functions salient, we discuss systems biological research on the mechanism(s) for countering heat shockthe Heat Shock Response (HSR) systemin Escherichia coli (E.coli) bacteria.

Luká Zámeník

Functional Linguistic Explanations

Generally speaking it is unsurprising that all explanations in linguistics are non-causal. According to contemporary debates (e. g. Newmeyer, 2017, Egré, 2015, Haspelmath, 2004), we can distinguish two major plausible types of explanations in linguistics – formal explanation, typical for generative grammar and, again broadly speaking, functional explanation, typical for cognitive linguistics. Formal explanation is derived from the internal systemic structure of the grammar of the language; functional explanation is derived from the external non-linguistic, and so non-systemic, needs of speakers.

Functional explanation in its more specific form is crucial for Quantitative Linguistics (QL), (Köhler 2012 and 1986). For QL language is a system of language subsystems (inter alia lexical, syntactic, semantic) and is directly connected with non-systemic conditions which form the system and are responsible for the evolution of language. Many of these non-systemic requirements are closely connected to economization principles (i.e. the principle of least effort).

The main general problem of functional explanation is its impreciseness (Newmeyer, 2017), the main specific problems of functional explanation for QL are the axiom of self-organization of the system (Zámeník, 2014) and the problem with functional equivalents (Köhler, 2012).

Accordingly, the goals of this paper are:

1. to establish a method to replace the axiom of self-organization (Beneová et. al., 2018).
2. to examine another category of non-causal explanation in order to eliminate the problem with functional equivalents (for current debates, vide inter alia Reutlinger, Saatsi, 2018, Kostic, 2016, Huneman, 2010).

Fabio Sterpetti

Non-Causal Explanations of Natural Phenomena and Naturalism

This paper invites a cautious attitude towards the claim that there really are non-causal scientific explanations of natural phenomena, by investigating whether a counterfactual account of mathematical explanations of natural phenomena (MENP) (Baker 2009) is compatible with a naturalist stance. Indeed, many philosophers claim that non-causal explanations of natural phenomena are ubiquitous in science and try to provide a unified account of both causal and non-causal scientific explanations (Reutlinger, Saatsi 2018). Among the different kinds of non-causal explanations of natural phenomena, MENP are regarded as paradigmatic examples of non-causal scientific explanations (Lange 2013). According to many philosophers, among the unified accounts of scientific explanations that have been proposed so far, the most promising ones are those that try to extend the counterfactual theory of scientific explanations to cover non-causal explanations (Reutlinger 2018). I thus focus on Baron, Colyvan and Ripley (2017) (BCR), since it is one of the most well-developed attempts to provide an account of MENP that is based on a counterfactual theory of scientific explanations. More precisely, I examine BCR account of why the shape of honeycomb cells is hexagonal. BCR account rests on the idea that through a counterfactual about mathematics, one can illuminate the reason why the shape of honeycomb cells cannot but meet an optimality requirement. I firstly analyse whether BCR account is an adequate explanation of honeycomb cells' shape, and then assess whether such account would be acceptable to those who wish to adopt a naturalist stance. To do that, I specify some minimal requirements a stance has to meet in order to be defined as naturalist. I show that BCR account of honeycomb cells' shape is unsatisfactory, because it is focused on the bidimensional shape of the cells, while actual cells are tridimensional, and the tridimensional shape of honeycomb cells does not meet any optimality requirement (Räz 2013). I also show that it might be in any case very difficult to make BCR account compatible with a naturalist stance, because of its metaphysical assumptions on how mathematics might constrain the physical domain. My claim is that such a kind of "explanations by constraint" (Bertrand 2018) is incompatible with a naturalist stance, because there is no naturalist account of how such a constrain might obtain.

Erlantz Etxeberria Altuna

When Causal and Non-Causal Explanations Compete against Each Other

Recent years have witnessed an increasing interest and acceptance of non-causal explanations, that is, explanations that do not cite causes of events, but focus instead on mathematical or geometrical relations to name a few (Lange 2011). In this paper I raise and tackle one potential problem that arises once we make room for mathematical and other non-causal explanations, namely, how to evaluate cases where both a causal and a non-causal are available for the same phenomenon and compete against each other. I begin by showing that it is in fact possible to provide alternative and competing explanations for the very same event. This situation is unproblematic when faced with a correct and an incorrect explanation of some event they and just one of them is right, but it might happen that there are two or more plausible explanations of a phenomenon. For instance, Lipton (2004) discusses the case where a pile of sticks is randomly thrown in the air and as they are falling to the ground, at any given point, there are more sticks that are close to the horizontal plane than to the vertical plane. He argues that the explanation is that there are more geometrical positions in which the stick can be in the horizontal plane (360 degrees) than positions there can be in the vertical plane (just two, up and down), so there will be more sticks closer to the horizontal plane. However, I argue that one can provide a causal explanation of the position of each and every stick, tracing back the movements that led the stick to be in such and such position, and thus explain the distribution of the sticks at one point is one that displays more of them in a horizontal plane. In scenarios like this, where one of the explanations is causal and the other is non-causal, how are we to evaluate which of them is better or a more appropriate explanation? I argue that one kind of explanation is not intrinsically superior to another kind, so for instance, we should not always favor causal explanations over non-causal ones; rather, it will depend on the circumstances of each explanandum. In order to help us compare and assess the merits of each competitor, I suggest a set of guidelines to follow.

1. Determine what is the explanandum question and verify that each competing explanation is addressing the

same question. If they are answering different questions, then it should be clear which of them fares better in precisely answering the explanation at stake.

2. Analyze the explanandum question carefully and note whether or not the question is already presupposes one preferred kind of explanation.

3. Compare the level of fundamentality of each explanation. There are cases where a mathematical explanation is a more fundamental explanation than its causal counterpart, or cases where one is reducible to the other.

4. Assess the explanatory depth of each explanation. If the other steps were not sufficient to determine which explanation is better, we can focus on their explanatory depth as a measurement of the amount of explanatory information they convey.

Elanor Taylor

Backing without Realism

Facts about explanation are often taken as a guide to facts about metaphysics. For example, some grounding theorists have argued that from the fact that there are non-causal explanations, it follows that there is a non-causal form of metaphysical determination. In debates about metaphysical fundamentality, the metaphysically fundamental is often taken to be equivalent to that which has no explanation. In each of these cases, facts about the availability and nature of explanation are used as guides to, or evidence for, facts about metaphysics.

Such inferences from explanation to metaphysics typically rely on two elements: first, explanatory realism, the view that it is a characteristic and necessary aspect of the nature of explanation to give information about metaphysical relations such as grounding or causation, and second, a backing model of explanation, according to which explanations are backed by certain supporting relations, such as causation. Combining explanatory realism with a backing model permits conclusions about metaphysics to follow straightforwardly from conclusions about explanation, because, on such an approach, all explanations are supported by metaphysical backing relations. These views pair together quite naturally, and those who endorse backing models of explanation have (at least typically) endorsed explanatory realism.

This paper will explore the prospects for a backing model without explanatory realism. I, among others, have argued that explanatory realism is false, and so I am interested in whether a backing model is viable once explanatory realism has been abandoned. However, the viability of a non-realist backing model is of more general interest, as this issue allows us to explore and understand the boundaries and commitments of backing models, and hence of explanation in general. Furthermore, much is at stake here for the practice of drawing conclusions about metaphysics from conclusions about explanation, and for the role of explanation in metaphysics more generally.

I will focus particularly on questions about the nature of the backing relations, and the formal features required of the backing relations such that they can play this supporting role with respect to explanation, including irreflexivity, asymmetry and non-monotonicity. I articulate a non-realist backing model, looking specifically at examples of apparent non-realist explanations and the nature and formal features of the backing relations that support them, including conceptual explanation, non-causal reason-based explanation, and logical explanation. Overall, I will show that a non-realist backing model is viable, can satisfy most of the desiderata met by the realist backing model, and can play a central and illuminating role in the practice of metaphysics.

Silvia Bianchi

Metaphysical Explanation in Scientific Weak Structuralism (WS): a Non-Foundationalist Conception of Grounding

The present paper starts from the possible alternatives to Metaphysical Foundationalism (MF) as recently discussed in Bliss & Priest (2018). My main objective is to introduce a further structuralist option, that I shall define Weak Structuralism (WS), with reference to the scientific structuralist debate on the individuality of quantum particles. The core idea is to articulate WS in terms of a non-foundationalist conception of metaphysical grounding.

According to MF, reality is hierarchically arranged with chains of entities ordered by anti-symmetric (AS), transitive (T) and anti-reflexive (AR) relations of ground/ontological dependence that are supposed to terminate in something fundamental – the extendability assumption (everything depends upon everything else) is rejected (¬ E).

Bliss and Priest significantly reconsider the standard idea of metaphysical dependence through a variety of counter-examples; among them, the most significant positions are coherentism (¬AR, ¬AS, T, E), according to which everything depends upon everything else, and infinitism (AR, AS, T, E), which states that there are no foundational elements.

My intention is to introduce WS as a form of coherentism which involves a mutual (not exactly symmetric) grounding relation. This notion appears to be strictly connected to metaphysical explanation; in particular, I will sustain that grounding just is metaphysical explanation (cf. Thompson, Bliss & Priest, 2018).

WS is characterized by two different grounding claims holding at the same time:

1. Objects Identity: the identity of objects (not their existence) is partially grounded in the relevant structure. This presupposes the interpretation of quantum particles as thin objects, e.g. relata whose identity is entirely structural, but whose existence (that include both structural and non-structural properties) is to be acknowledged if relations are to be posited.

2. Structure Existence: the existence of physical structure (not its identity) is fully grounded in the individual objects, as relations require relata to be physically admitted – though these relata are not proper individuals.

3. Structure Identity: the identity of physical structure is fully grounded in the correspondent mathematical structure which, in line with Wigglesworth (in Bliss & Priest, 2018), results in an unlabelled graph individuated by its isomorphism class.

The individuation of mathematical structures provides a bound from below for the notion of grounding, that may hold for WS as well: the identity of mathematical structures serves as a full ground for the identity of both physical structure and individual objects.

This conception seems consistent with WS notion of extendability: the mutuality of the global picture makes objects and structures ontologically on a par, thus being not finitely grounded. However, the idea of a lower bound expresses a non-standard interpretation of well-foundedness – one in which there is not a finite number of steps between a fact and what grounds it.

In a nutshell, WS involves ¬AS, AR, T, E, where ¬AS and E are weakly interpreted and AR – as opposed to coherentism can be endorsed again: in WS, each grounding relation is asymmetrical on its own and does not lead back to the starting point (there is not something that has to be self-grounded).

Therefore, on the one hand, WS entails a broader, non-foundationalist approach to metaphysical explanation, where objects and structures are actually on a par; on the other hand, a foundationalist background can be preserved, so as to evade some typical circularity objections that may affect (non-foundationalist) structuralist ontologies.

Jon Erling Litland

Real Definition, Opacity, and Ground.

It is tempting to think of real definitions as identifications. If $s(1)$–the successor of 1–is the real definition of 2, then 2 is identical to s(1). But it is also tempting to think of real definitions as explanatory: the definiendum asymmetrically depends on the definiens. It seems we cannot hold both views: if $2 = s(1)$ and 2 depends on $s(1)$, then 2 depends on 2, by Leibniz's Law. Correia (2017) opts to hold that definitional contexts are opaque, rejecting Leibniz's Law; Dorr (2016) rejects that the definiendum asymmetrically depends on the definiens. In this paper I develop a way of expressing real definitions allowing the definiendum to depend on the definiens without being forced to say that real definitions are opaque. I then use the framework to propose real definitions of logical operations.

I propose we express real definitions by means of a predicate modifier δ that attaches to a predicate P to yield the predicate δP. (Cf. Fine 1994 on the expression of essentialist claims.) We may read this as "is by definition P". To express that 2 is defined as the successor of 1 we start with the successor relation S. We first form the predicate $(\lambda x.Sx1))$–"being the successor of 1"; we then apply δ to get the predicate $\delta(\lambda x.Sx1)$–"being by definition the successor of 1". The real definition of 2 is then:

(1) $\delta(\lambda x.Sx1)2$

Say that an object depends on anything that figures in its real definition. We then see that 2 depends on 1 and the successor relation. However, since the functional term "$s(1)$" does not figure in the definition of 2, we cannot use the fact that $2 = s(1)$ to conclude that 2 depends on 2.

This approach to real definition is not restricted to definitions of objects. By working in a type-theoretic framework we can make sense of defining items of higher type, for instances the logical operations themselves. Here is a view about the definition of conjunction ($\wedge$). Conjunction is the unique operation C such that the immediate grounds for the $C(p, q)$ are exactly p, q. To make this precise, we work in a relational type theory, where for each type τ, we also have the plural type $[\tau]$–the type of pluralities of type τ. (When t, s are expressions of type τ, let us use $[t; s]$ as a term for the plurality that contains just t, s.) The immediate grounding relation $\Rightarrow$ is of type $\langle[\langle\rangle], \langle\rangle\rangle$; – it is a relation holding between pluralities of propositions and propositions.

One might then express the real definition of $\wedge$ as follows:

(2) $(\delta\lambda x^{\langle\langle\rangle,\langle\rangle\rangle}.\forall p\forall q([p, q] \Rightarrow x[p, q]))\wedge$

This is promising, but if the definition of dependence is correct, this makes $\wedge$ depend on the universal quantifier $\forall$. In the remainder of the paper I explore some ways in which we can avoid dependence on the universal quantifier, and generalize the account to deal with other logical operations.

Joke Meheus

"Because Ann melted, she did not put the butter in the fridge". What the logical study of Dutch causal connectives can teach for the study of non-causal explanation

The Dutch language contains four different so-called *backward causal connectives*: "doordat", "omdat", "want", and "aangezien". In some cases, the four express a causal relation and can be substituted for one another, without a significant change in meaning. For instance, the following four sentences (taken from Pit (2003)) can all be translated in English by "The butter has melted because Ann did not put it in the fridge." and amount to "The melting of the butter is caused by the fact that Ann did not put it in the fridge.":

(1) De boter is gesmolten, doordat Ann haar niet in de koelkast heeft gelegd.
[The butter has melted] **doordat** [Ann did not put it in the fridge].

(2) De boter is gesmolten, omdat Ann haar niet in de koelkast heeft gelegd.
[The butter has melted] **omdat** [Ann did not put it in the fridge].

(3) De boter is gesmolten, want Ann heeft haar niet in de koelkast gelegd.
[The butter has melted] **want** [Ann did not put it in the fridge].

(4) De boter is gesmolten, aangezien Ann haar niet in de koelkast heeft gelegd.
[The butter has melted] **aangezien** [Ann did not put it in the fridge].

In other cases, there are limits to their interchangeability (see, for instance, Pit (2003)). In (5), for example, “want” can be substituted with “aangezien” without meaning change, but not with “doordat” or “omdat”—(7) and (8) have a completely different meaning. In (5) and (6), “want” and “aangezien” connect a *conclusion* to an *argument* for that conclusion, and not a caused effect to a causing event as in (1)-(4). What (5) and (6) come to is: “I (the author of the sentence) conclude that Ann has not put the butter in the fridge, and I do so on the basis of the observation that it has melted”. In (7) a different relation is expressed, namely that between an agent’s action and a *reason* the agent has for that action: “Ann has not put the butter in the fridge and her reason for doing so is that it has melted”. (8) is ambiguous between two readings, but in both readings a causal link is claimed to exist, be it a surprising one: “the melting of *Ann* caused Ann not to put the butter in the fridge”, and “the melting of *the butter* caused Ann not to put it in the fridge”.

(5) Ann heeft de boter niet in de koelkast gelegd want ze is gesmolten.
[Ann did not put the butter in the fridge] **want** [the butter has melted].

(6) Ann heeft de boter niet in de koelkast gelegd aangezien ze is gesmolten.
[Ann did not put the butter in the fridge] **aangezien** [the butter has melted].

(7) Ann heeft de boter niet in de koelkast gelegd omdat ze is gesmolten.
[Ann did not put the butter in the fridge] **omdat** [the butter has melted].

(8) Ann heeft de boter niet in de koelkast gelegd doordat ze is gesmolten. (?)
[Ann did not put the butter in the fridge] **doordat** [the butter has melted].

That backward causal connectives cannot always be subsituted for one another has also been observed in other languages: “parce que”, “car” and “puisque” in French and “weil”, “da” and “denn” in German have similar effects as “omdat”, “want” and “aangezien” in Dutch (see Pit (2007)):

(5a) Ann heeft de boter niet in de koelkast gelegd **want** ze is gesmolten.
(5b) Ann n’a pas mis le beurre au frigo, **puisqu’il** est fondu.
(5c) Ann hat die Butter nicht in den Kühlschrank gestellt, **denn** sie ist flüssig geworden.
(6a) Ann heeft de boter niet in de koelkast gelegd **aangezien** ze is gesmolten.
(6b) Ann n’a pas mis le beurre au frigo, **car** il est fondu.
(6c) Ann hat die Butter nicht in den Kühlschrank gestellt, **da** sie flüssig geworden ist.
(7a) Ann heeft de boter niet in de koelkast gelegd **omdat** ze is gesmolten.
(7b) Ann n’a pas mis le beurre au frigo, **parce qu**’il est fondu.
(7c) Ann hat die Butter nicht in den Kühlschrank gestellt, **weil** sie flüssig geworden ist.

What the above examples show is that, in natural languages, backward causal connectives do not always express causal relations, and may even express relations that are not explanatory, as in (5)-(6) and (7). They also show that in some natural languages different causal connectives “specialize” in different relations. Whereas in Dutch “doordat” can only be used for cause-effect relations, an argument-conclusion relation can, in its backward direction, only be expressed by “want” and “aangezien”, and a reason-action relation in its backward direction only by “omdat”.

In other languages, such as English, this particular specialization is absent. This may explain that an asymmetry occurs in the ease of processing the different relations in English (see Traxler et al. (1997)), but not in Dutch (see Pit (2003)). While (10a) has been shown to take longer to process than (9a), no such difference is observed for their Dutch translations:

(9a) There are holes in Ann’s clothes, **because** there are moths in her cupboard.
(9b) Er zijn gaten in Anns kleren **want** er zitten motten in haar kast.
(10a) There are moths in Ann’s cupboard, **because** there are holes in her clothes.
(10b) Er zitten motten in Anns kast **want** er zijn gaten in haar kleren.

The argument-conclusion relation as we find it in (5)-(6) and in (10) is called *diagnostic* (as opposed to causal) in Traxler et al. (1997) and *evidential* or *inferential* in Schnieder (2011) (as opposed to explanatory).

The main aim of the paper is to present a formal logic for the Dutch “want” in both its senses—the explanatory one from (9) will be explicated by the connective want_1 and the diagnostic one from (10) by want_2—, and to examine the relation of both connectives with (noncausal) explanation. The logic, which will be called **WANT**, will be formulated within the framework for abduction from Batens (2017), but will be extended so that not only “want-statements” with a particular “antecedent” can be dealt with, as in (11), but also those with a general “antecedent”, as in (12):

(11) Deze boon komt uit deze zak, want ze is wit.
[This bean is from this bag], **want** [it is white].
(12) Deze bonen komen uit deze zak, want ze zijn wit.
[These beans are from this bag], **want** [they are white].

After presenting **WANT**, I shall discuss the relation with inference to the best explanation, and show that the connective want_1 from **WANT** enables one to “summarize” in a single statement the result of an abductive inference, provided the abductive conclusion is (at least defeasibly) accepted to be true. As the implication in **WANT** is the material one, its application is restricted to noncausal statements (like (11) and (12)). I shall, however, address the question how **WANT** may be extended to handle causal abductive inferences as well.

Next, I shall compare **WANT** to the logic **BC** from Schnieder (2011), which is claimed to be a logic for *because* in its explanatory sense. I shall argue that, unlike what is claimed by the author, this logic does not provide an explication of the *explanatory because* from natural language discourse, but that the connective want_2 from **WANT** does.

I shall end with some philosophical implications for the current debate on noncausal explanation, and show how the distinction between want_1 and want_2 may help one to delineate explanatory relations, and to distinguish them from justificatory relations. This will lead to a characterization of “noncausal explanation” that is more stringent than that it is a statement that contains some “causal connective” without being causal.

Joachim Frans

Mathematical Explanation and Mathematical Concepts

Most philosophers and mathematicians today agree that a lot more can (and is) achieved in mathematical practice than the mere establishment of mathematical truths. Aspects such as explanatoriness, among others, should not be passed over lightly.

Some philosophers are skeptic about the idea that talk about explanation in mathematics is something more than gestures about an aesthetic or subjective value (e.g. Zelcer 2013). Nevertheless, others argue that there are in fact explanations in pure mathematics (Mancosu 2008). Given the abstract nature of mathematics, this requires an analysis beyond traditional causal accounts of explanation. The study of explanation in mathematics mainly consists of the modest tradition of investigating differences between explanatory and non-explanatory proofs. Steiner (1978) can be seen as the starting point for contemporary discussions. The core idea is that while all proofs show that a theorem is true, some proofs also show why a theorem is true.

I suggest we take the possibility that there are explanations in pure mathematics seriously. My main concern for this talk is the following tension. On the one hand, philosophers often suggest that proofs are not the only loci of explanation. On the other hand work on mathematical explanation focuses almost exclusively on the relation between proofs and theorems. Lange (2016) and D'Allesandro (forthcoming) are recent exceptions. In my talk, I will look at what it could mean to explain a mathematical concept. More precisely, I will look at a specific period in the history of mathematics, namely the introduction of complex numbers in algebra, to argue that there are cases where the mathematical community had the aim of making a concept more intelligible. In order to fully account for mathematical practice, we need to make sense of these cases as well. This requires that the study of mathematical explanation extends beyond the study of the notion of an explanatory proof.

Atoosa Kasirzadeh

Can Mathematics Really Make a Difference?

One of the central issues in the philosophy of science is whether we can have a general theory of scientific explanation. One standing proposal is a counterfactual-based theory. Baron et al. (2017) extend the counterfactual analysis of causal explanations to non-causal and mathematical cases. Their proposal is the most elaborate attempt in the literature to roll non-causal and mathematical explanations into a general theory of explanation. This paper argues that this extension fails to offer a true general theory of explanation. In particular, I argue that there cannot be a difference-making counterfactual analysis of merely mathematical and non-causal explanations of empirical phenomena under commonly held assumptions about mathematics in scientific practice. I offer an alternative approach to Baron et al's proposal by distinguishing between two kinds of mathematical and non-causal explanations of empirical phenomena. Partially mathematical explanations are those in which mathematical facts together with empirical facts explain the empirical phenomena. Merely mathematical explanations are those in which only purely mathematical facts establish the explanation of empirical phenomena. I argue that we can have a standard counterfactual analysis of partially non-causal and mathematical explanations, such as optimality explanations, by twiddling empirical rather than purely mathematical facts of the antecedent. On the other hand, twiddling purely mathematical facts in the antecedent of merely mathematical and non-causal explanations always leads to contradiction and provides no explanatory benefit. I conclude that a general counterfactual analysis of merely mathematical and non-causal explanations becomes very costly when compared with the explanatory benefits of counterfactual analysis. If we take scientific practice seriously, mathematics, standing alone, cannot make a difference to the empirical phenomena.